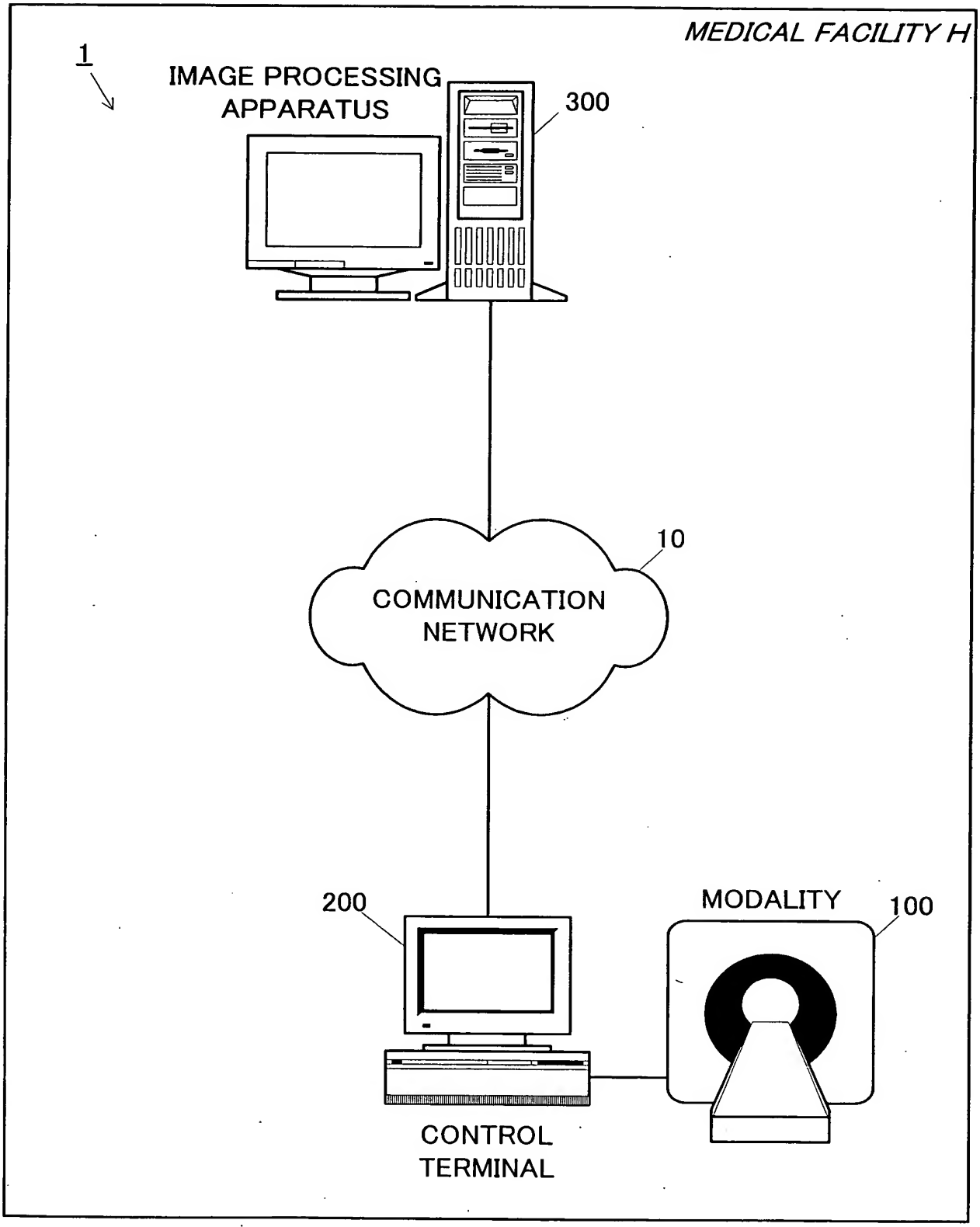

MEDICAL FACILITY H
1
IMAGE PROCESSING APPARATUS
300
10
COMMUNICATION NETWORK
200
MODALITY
100
CONTROL TERMINAL

FIG.1

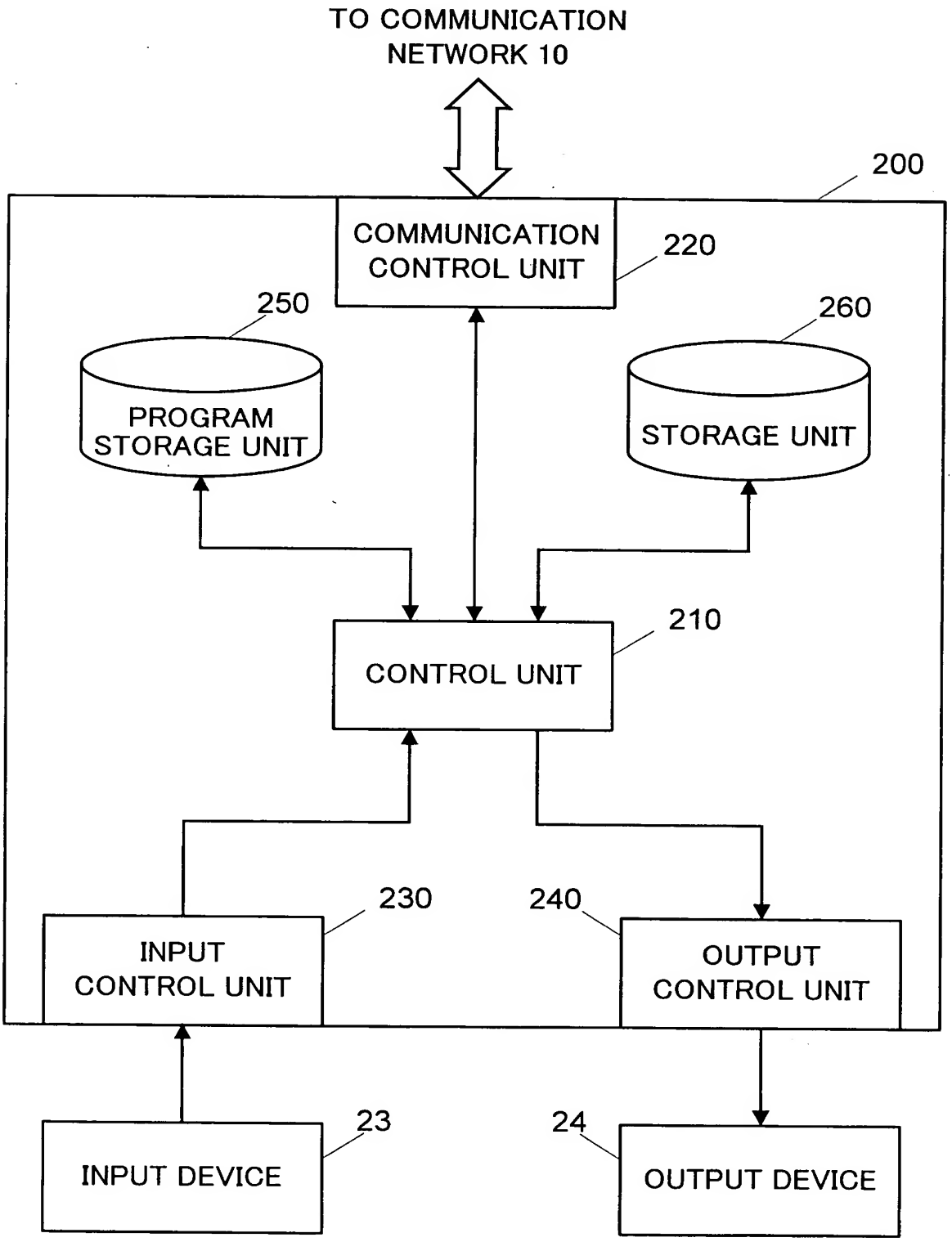
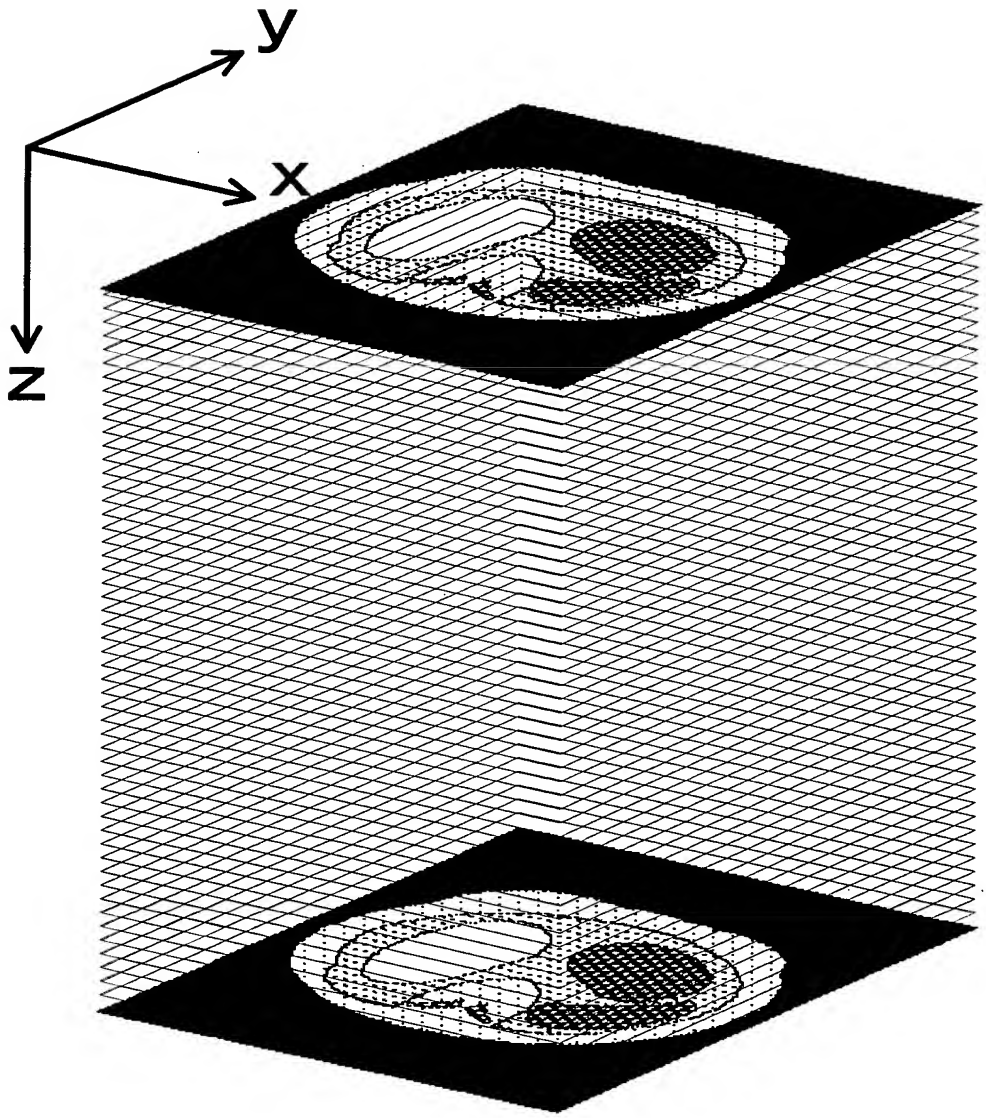

TO COMMUNICATION NETWORK 10
200
COMMUNICATION CONTROL UNIT
220
250
PROGRAM STORAGE UNIT
260
STORAGE UNIT
CONTROL UNIT
210
230
INPUT CONTROL UNIT
240
OUTPUT CONTROL UNIT
23
INPUT DEVICE
24
OUTPUT DEVICE

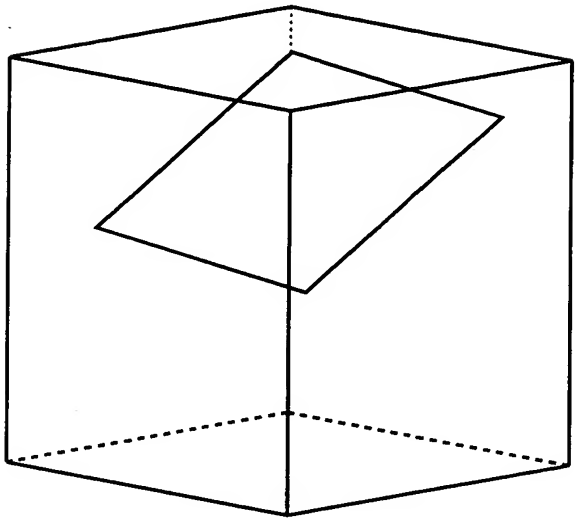
FIG.2



SLICE IMAGE

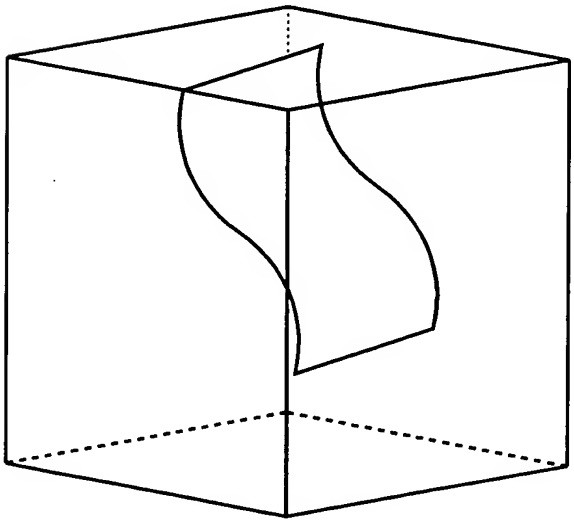
BEST AVAILABLE COPY

FIG.3



MPR

FIG.4A



CPR

FIG.4B

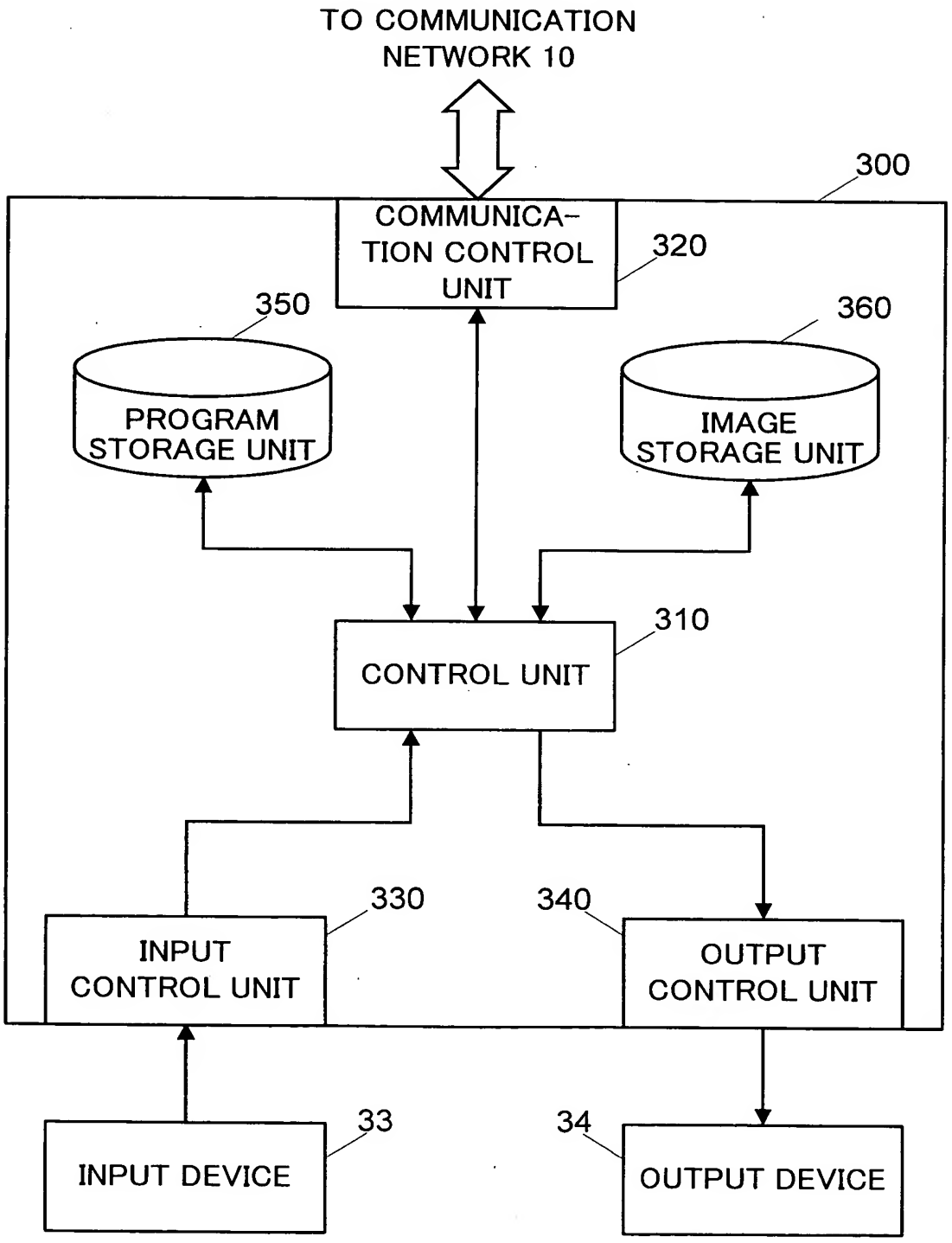

TO COMMUNICATION NETWORK 10
300
COMMUNICA-TION CONTROL UNIT
320
350
PROGRAM STORAGE UNIT
360
IMAGE STORAGE UNIT
310
CONTROL UNIT
330
INPUT CONTROL UNIT
340
OUTPUT CONTROL UNIT
33
INPUT DEVICE
34
OUTPUT DEVICE

FIG.5

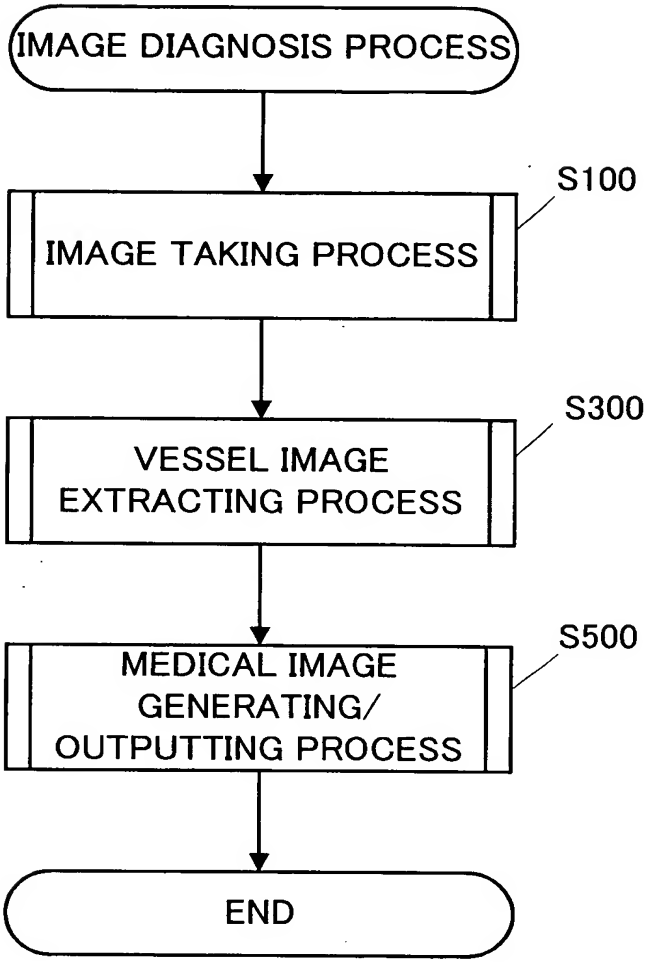


IMAGE DIAGNOSIS PROCESS
S100
IMAGE TAKING PROCESS
S300
VESSEL IMAGE EXTRACTING PROCESS
S500
MEDICAL IMAGE GENERATING/ OUTPUTTING PROCESS
END

FIG.6

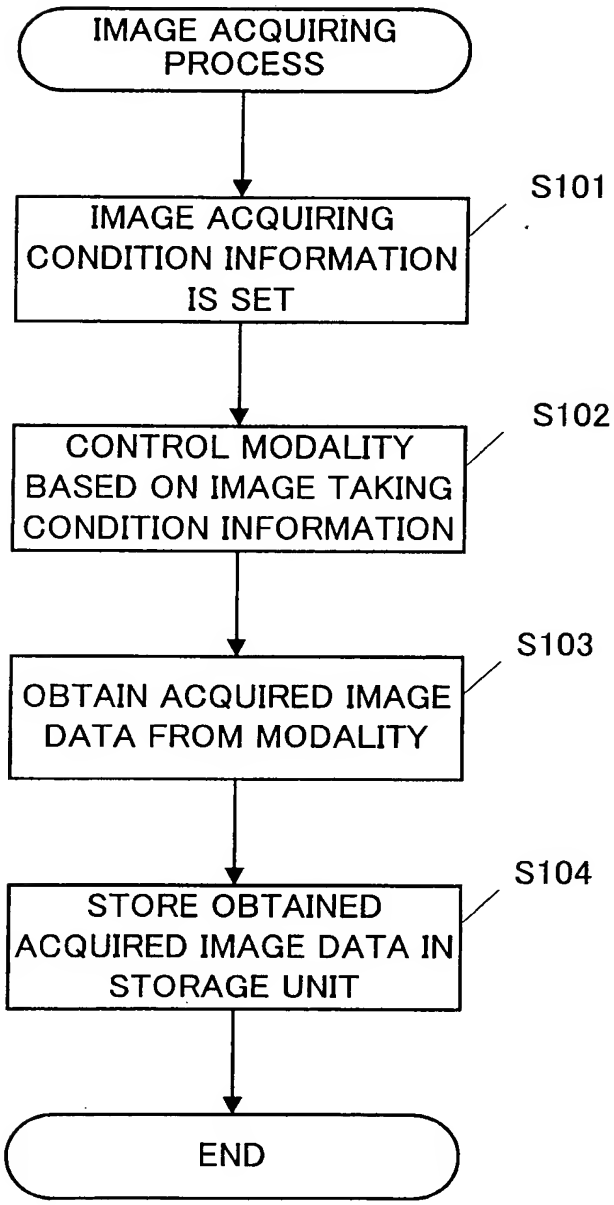


IMAGE ACQUIRING PROCESS
IMAGE ACQUIRING CONDITION INFORMATION IS SET
S101
CONTROL MODALITY BASED ON IMAGE TAKING CONDITION INFORMATION
S102
OBTAIN ACQUIRED IMAGE DATA FROM MODALITY
S103
STORE OBTAINED ACQUIRED IMAGE DATA IN STORAGE UNIT
S104
END

FIG.7

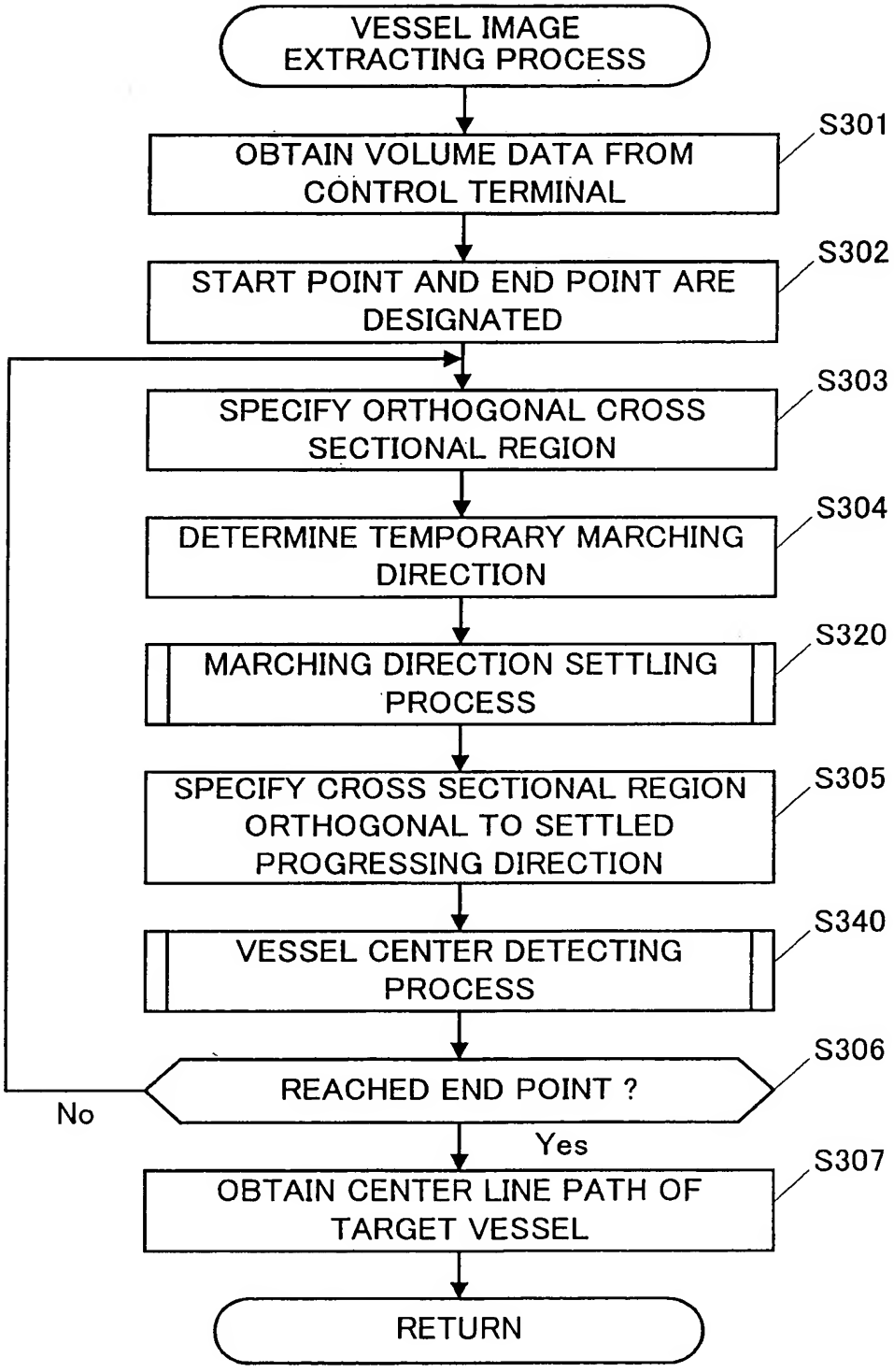

VESSEL IMAGE EXTRACTING PROCESS
OBTAIN VOLUME DATA FROM CONTROL TERMINAL
S301
START POINT AND END POINT ARE DESIGNATED
S302
SPECIFY ORTHOGONAL CROSS SECTIONAL REGION
S303
DETERMINE TEMPORARY MARCHING DIRECTION
S304
MARCHING DIRECTION SETTLING PROCESS
S320
SPECIFY CROSS SECTIONAL REGION ORTHOGONAL TO SETTLED PROGRESSING DIRECTION
S305
VESSEL CENTER DETECTING PROCESS
S340
REACHED END POINT ?
S306
No
Yes
OBTAIN CENTER LINE PATH OF TARGET VESSEL
S307
RETURN

FIG.8

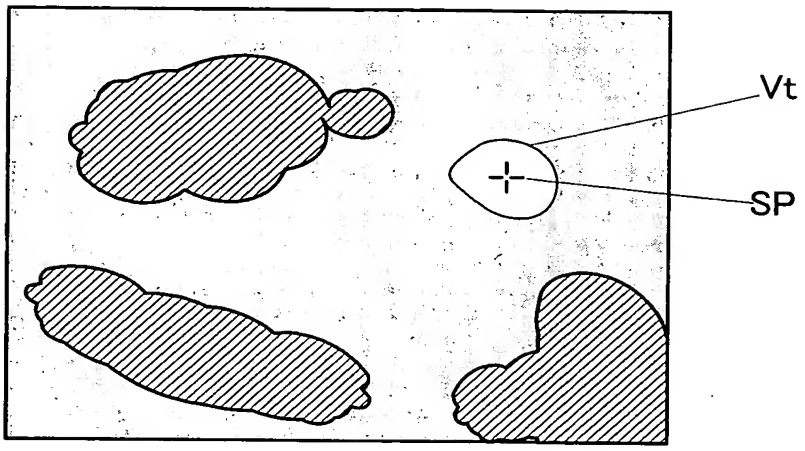


FIG.9A

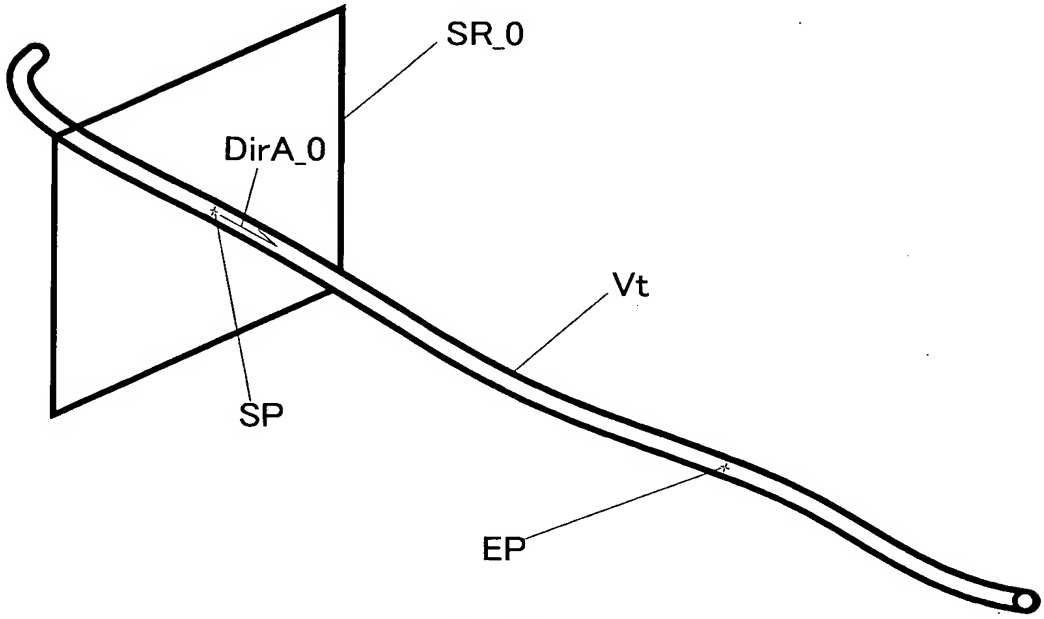


FIG.9B

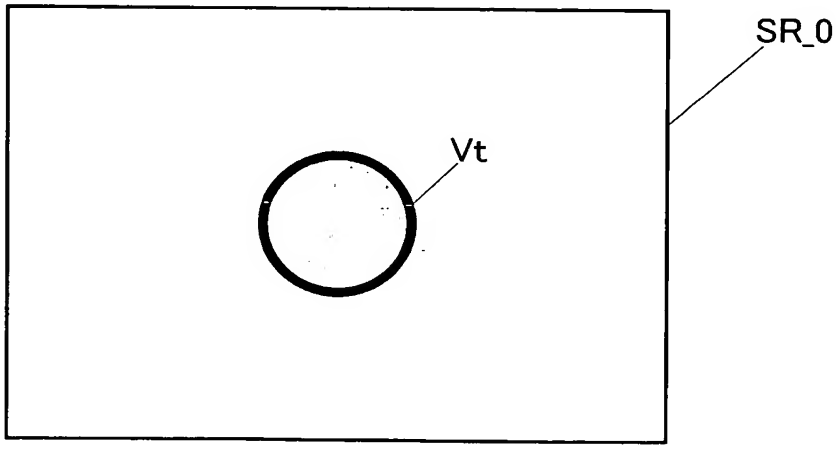


FIG.9C

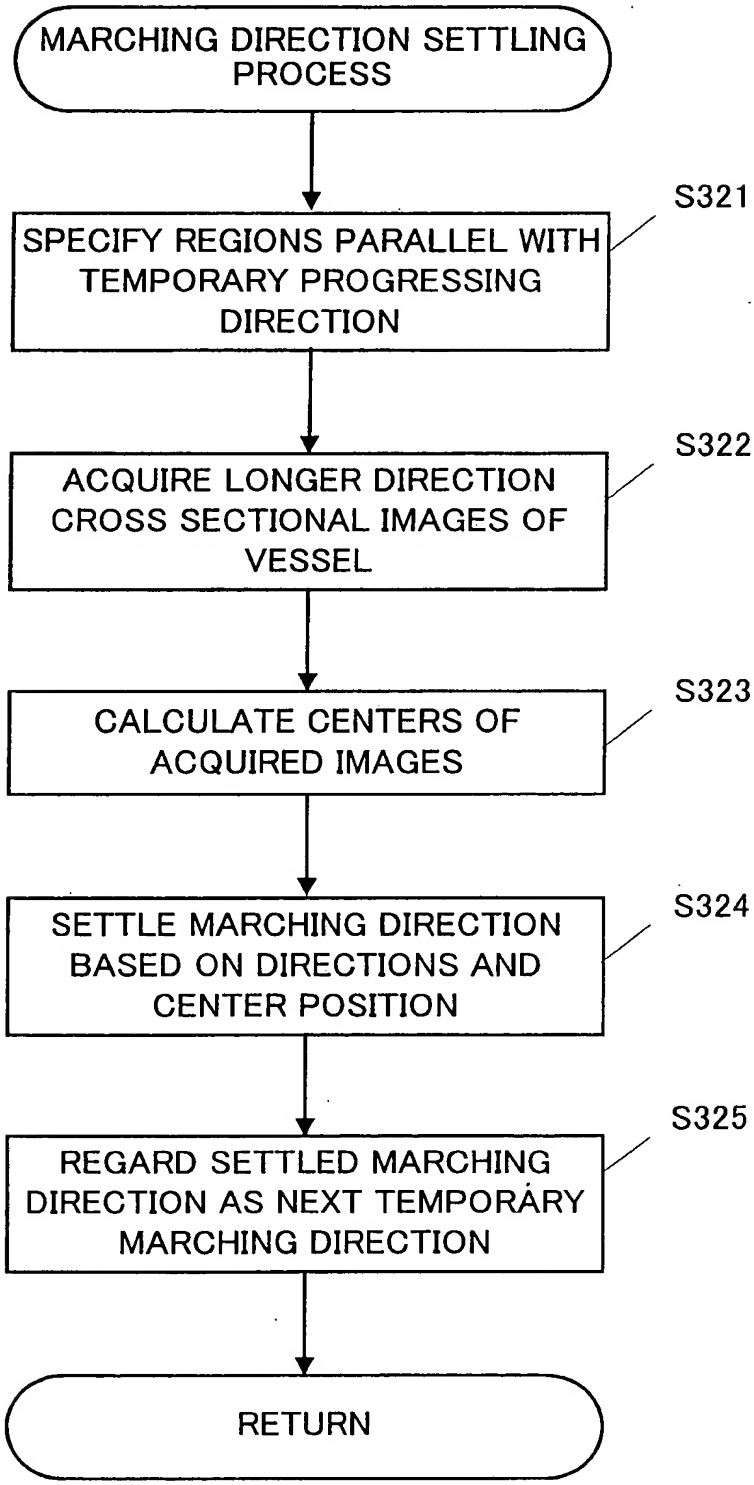

MARCHING DIRECTION SETTLING PROCESS
SPECIFY REGIONS PARALLEL WITH TEMPORARY PROGRESSING DIRECTION
S321
ACQUIRE LONGER DIRECTION CROSS SECTIONAL IMAGES OF VESSEL
S322
CALCULATE CENTERS OF ACQUIRED IMAGES
S323
SETTLE MARCHING DIRECTION BASED ON DIRECTIONS AND CENTER POSITION
S324
REGARD SETTLED MARCHING DIRECTION AS NEXT TEMPORARY MARCHING DIRECTION
S325
RETURN

FIG.10

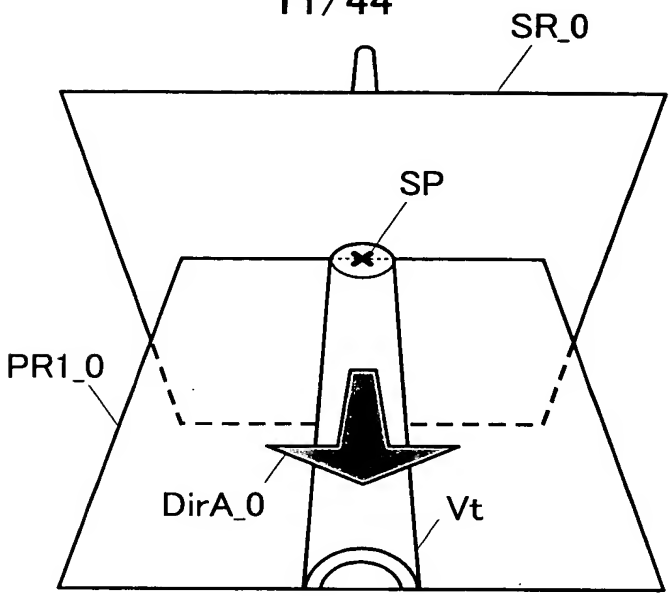


FIG.11A

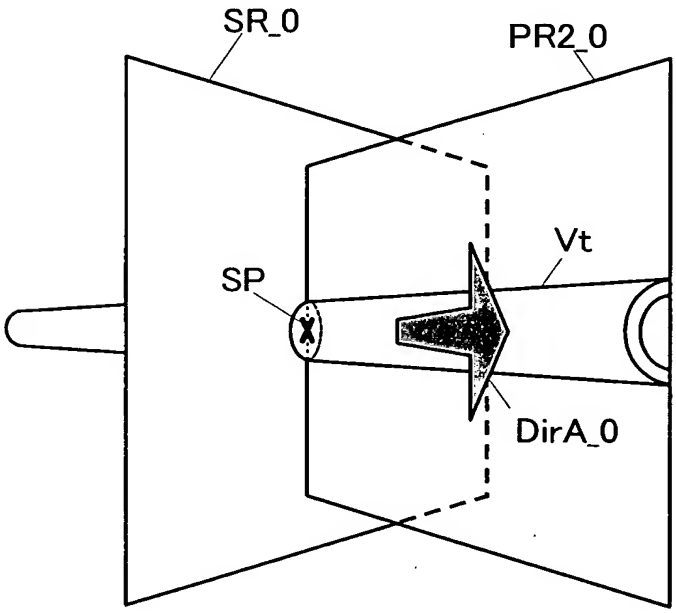


FIG.11B

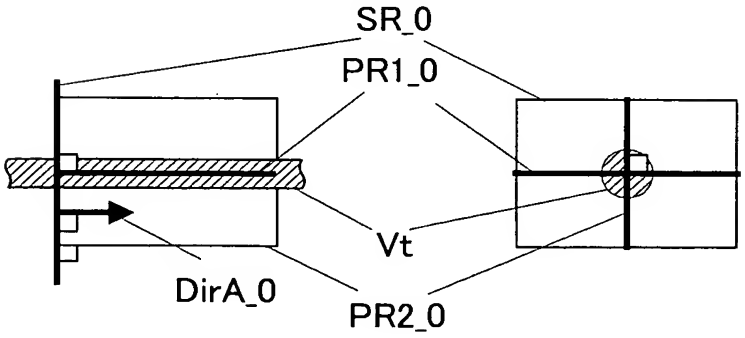


FIG.11C

FIG.11D

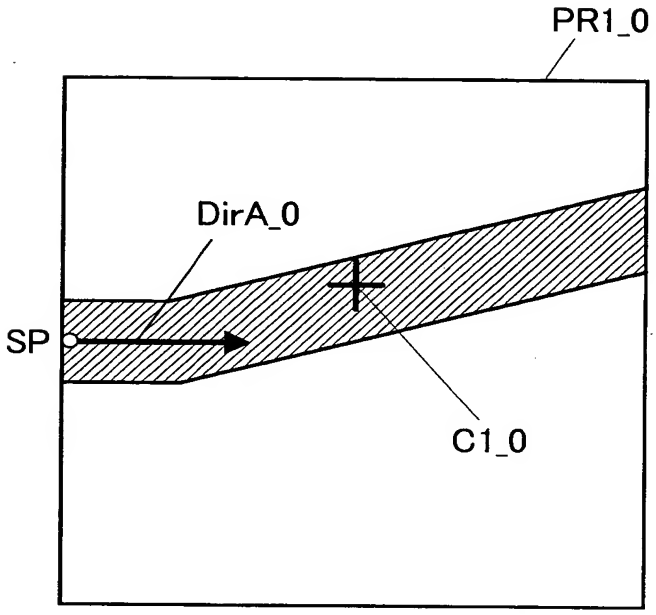


FIG.12A

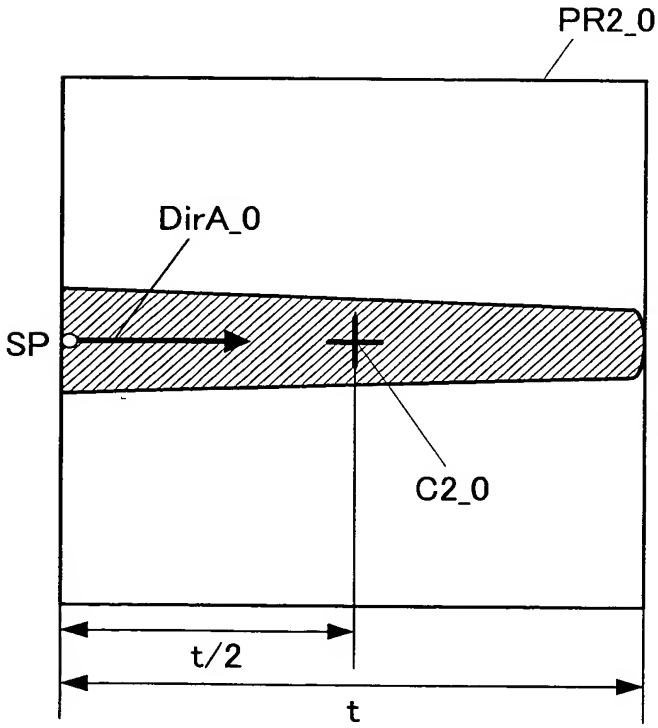


FIG.12B

MARCHING (ADVANCING, PROGRESSING) DIRECTION SETTLING FORMULAE

n 1 : UNIT VECTOR PARALLEL TO TEMPORARY MARCHING DIRECTION DirA
n 2 : UNIT VECTOR PERPENDICULAR TO REGION PR1
n 3 : UNIT VECTOR PERPENDICULAR TO REGION PR2
v 2 : POSITION VECTOR OF CENTER POSITION ON REGION PR1
v 3 : POSITION VECTOR OF CENTER POSITION ON REGION PR2

IN CASE OF $v2 \cdot n1 > v3 \cdot n1$

VECTOR TO NEXT POSITION $= v2' \cdot n1 * n1 + v2' \cdot n3 * n3 + v3 \cdot n2 * n2$

WHERE $v2' = v3 \cdot n1 / v2 \cdot n1 * v2$

IN CASE OF $v2 \cdot n1 \leqq v3 \cdot n1$

VECTOR TO NEXT POSITION $= v2 \cdot n1 * n1 + v2 \cdot n3 * n3 + v3' \cdot n2 * n2$

WHERE $v3' = v2 \cdot n1 / v3 \cdot n1 * v3$

(· REPRESENTS INNER PRODUCT OF VECTORS
* REPRESENTS OUTER PRODUCT OF VECTORS)

FIG.13

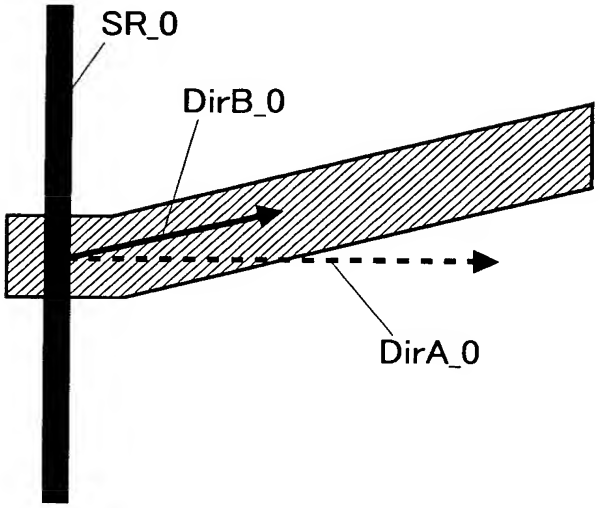


FIG.14A

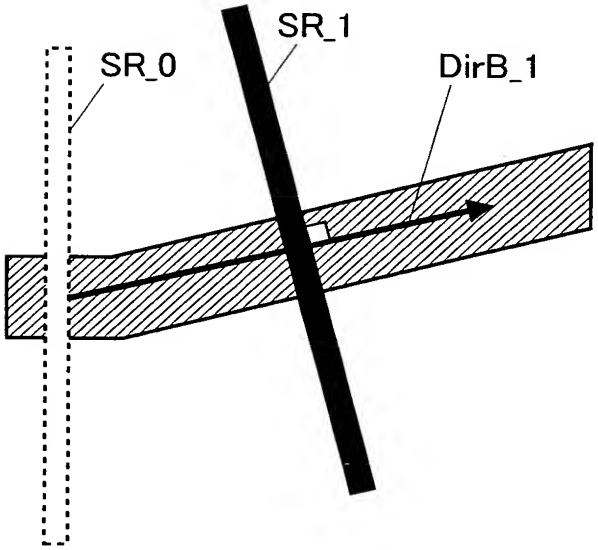


FIG.14B

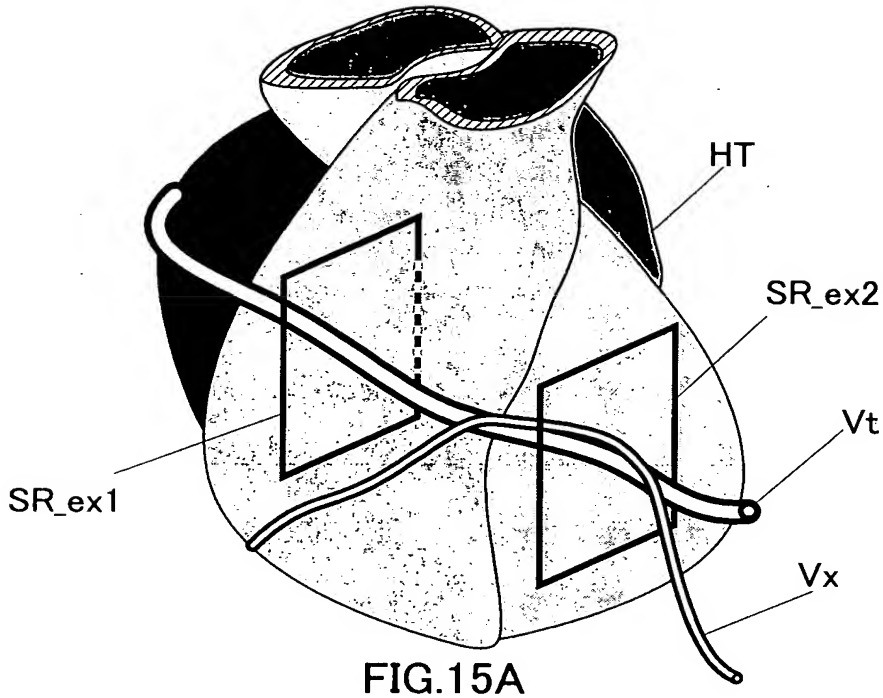


FIG.15A

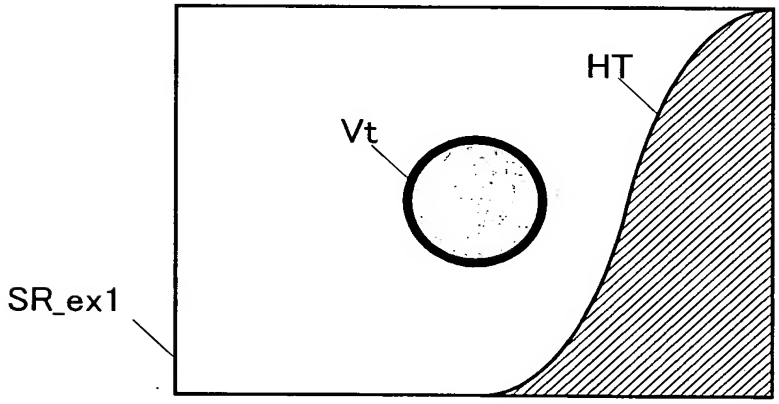


FIG.15B

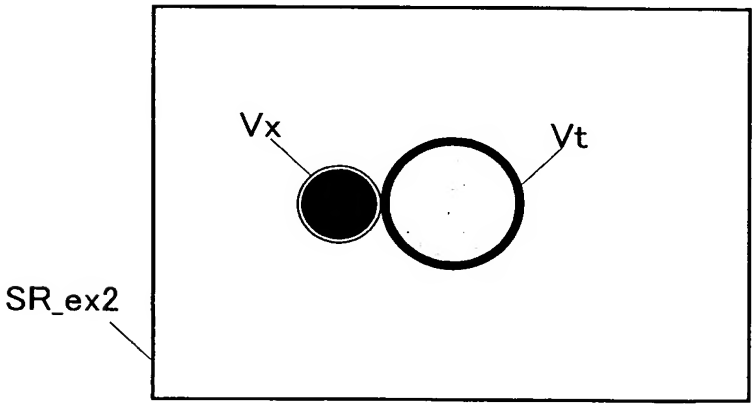


FIG.15C

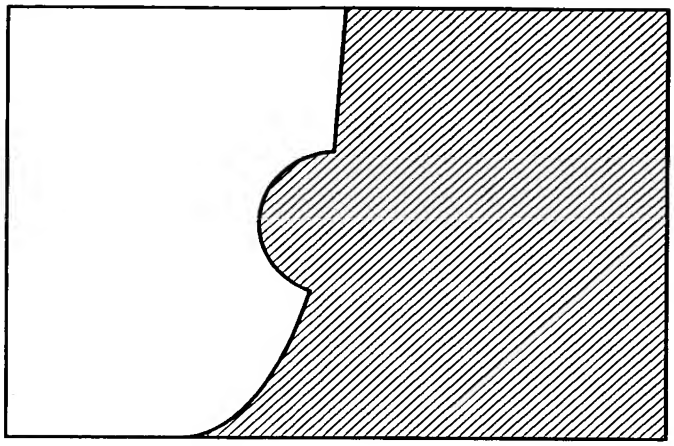


FIG.16A

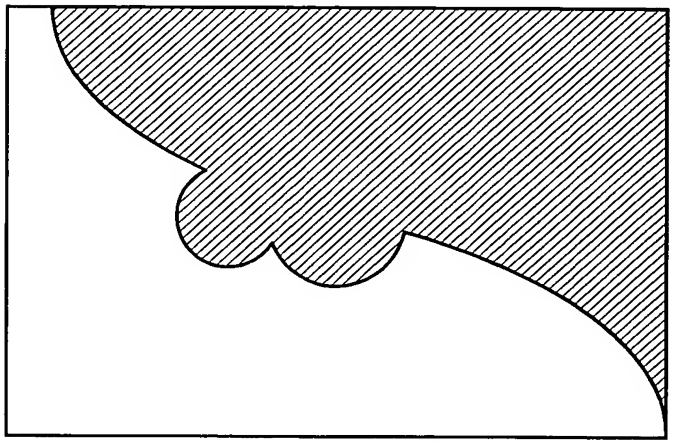


FIG.16B

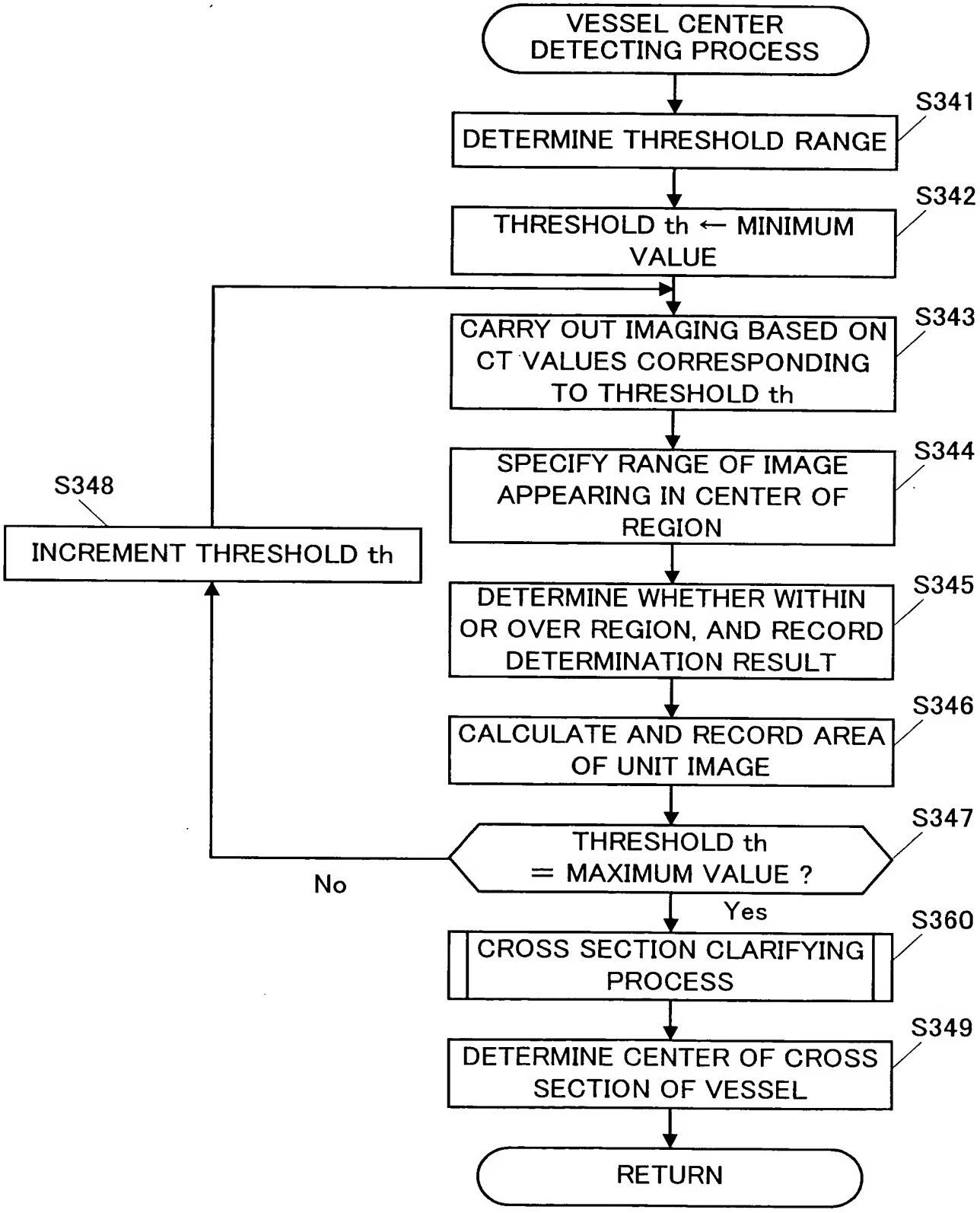

VESSEL CENTER DETECTING PROCESS
S341
DETERMINE THRESHOLD RANGE
S342
THRESHOLD th ← MINIMUM VALUE
S343
CARRY OUT IMAGING BASED ON CT VALUES CORRESPONDING TO THRESHOLD th
S344
SPECIFY RANGE OF IMAGE APPEARING IN CENTER OF REGION
S345
DETERMINE WHETHER WITHIN OR OVER REGION, AND RECORD DETERMINATION RESULT
S346
CALCULATE AND RECORD AREA OF UNIT IMAGE
S347
THRESHOLD th = MAXIMUM VALUE ?
No
Yes
S348
INCREMENT THRESHOLD th
S360
CROSS SECTION CLARIFYING PROCESS
S349
DETERMINE CENTER OF CROSS SECTION OF VESSEL
RETURN

FIG.17

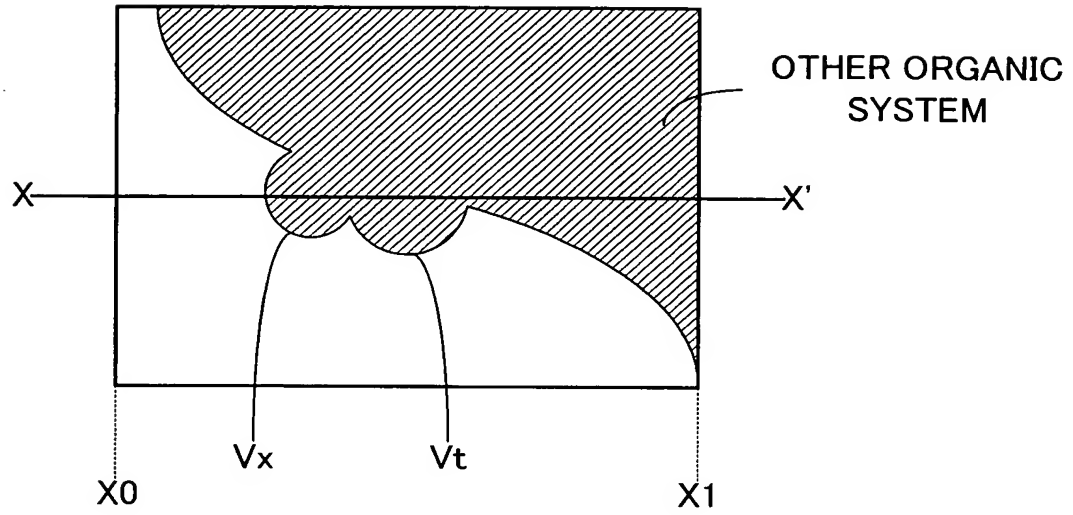


FIG.18A

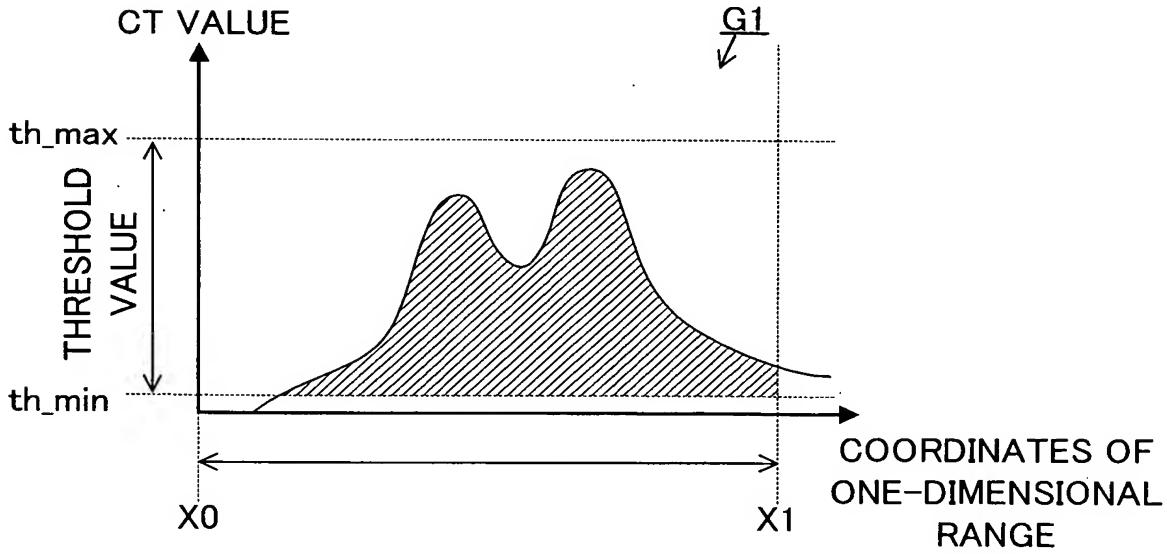


FIG.18B

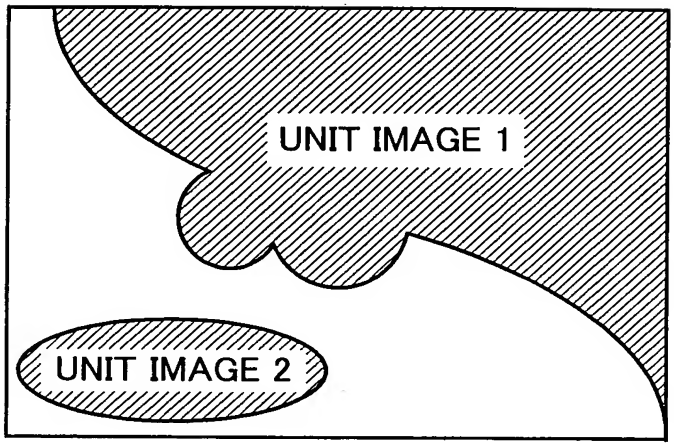


FIG.19A

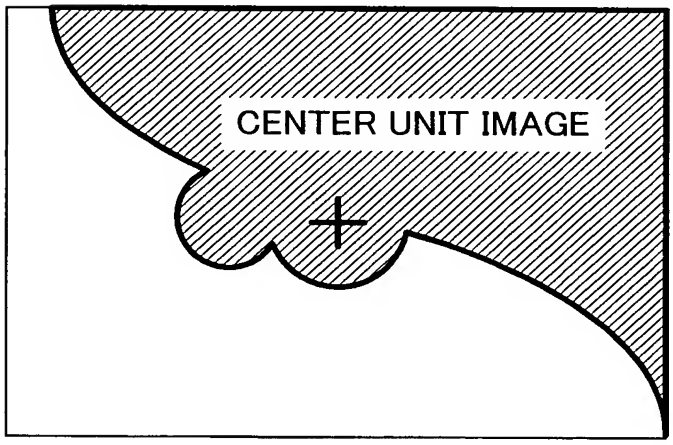


FIG.19B

THRESHOLD ATTRIBUTE TABLE

THRESHOLD	WITHIN REGION ?	AREA VALUE
th_min	NO	1000
th_min+1	NO	900
th_min+2	NO	800
th_min+3	NO	700
⋮	⋮	⋮
th_max−3	YES	30
th_max−2	YES	20
th_max−1	YES	10
th_max	YES	0

FIG.20

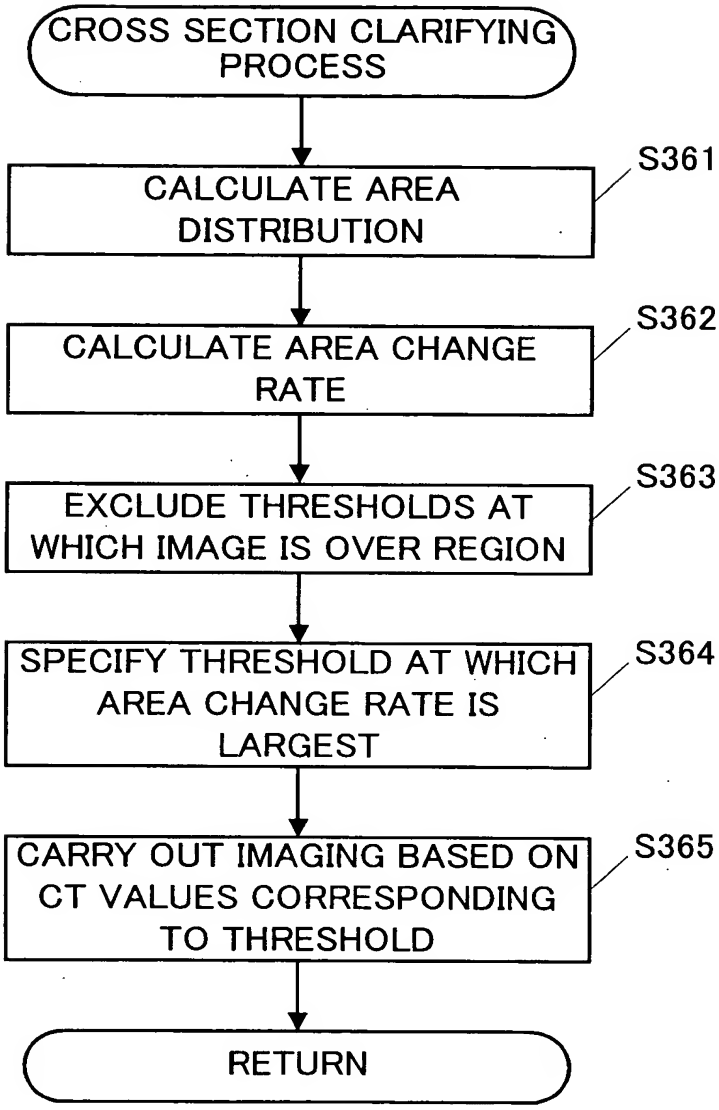

CROSS SECTION CLARIFYING PROCESS
CALCULATE AREA DISTRIBUTION
S361
CALCULATE AREA CHANGE RATE
S362
EXCLUDE THRESHOLDS AT WHICH IMAGE IS OVER REGION
S363
SPECIFY THRESHOLD AT WHICH AREA CHANGE RATE IS LARGEST
S364
CARRY OUT IMAGING BASED ON CT VALUES CORRESPONDING TO THRESHOLD
S365
RETURN

FIG.21

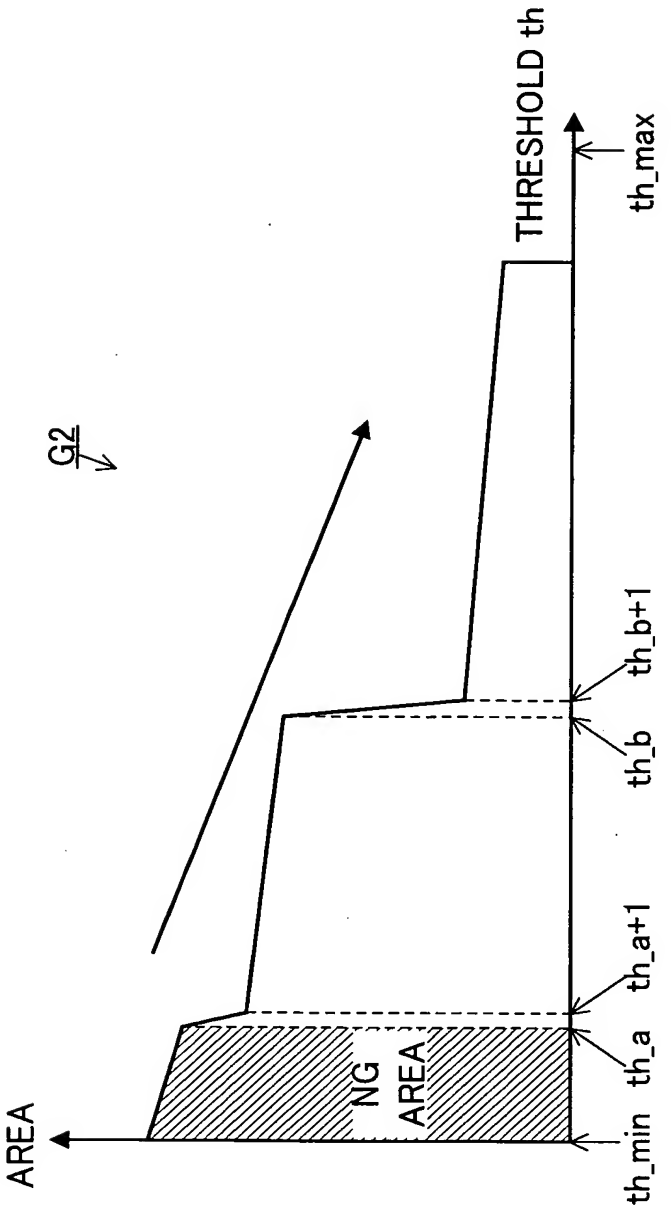


FIG.22

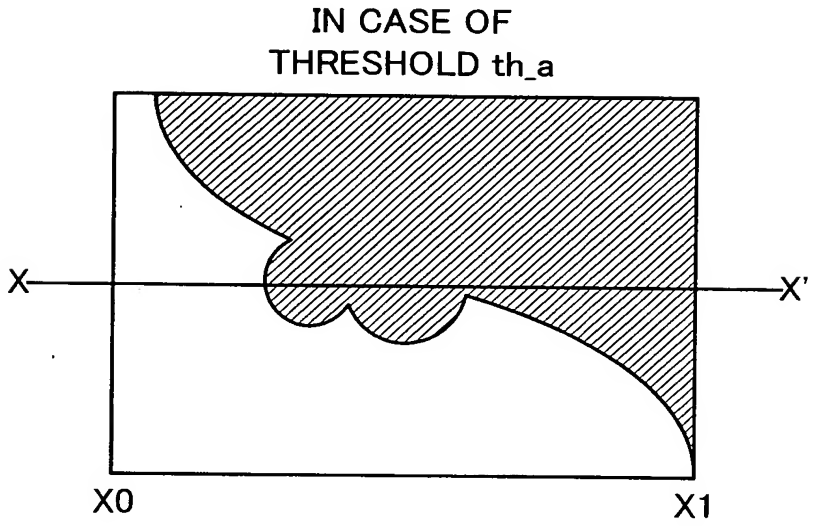


FIG.23A

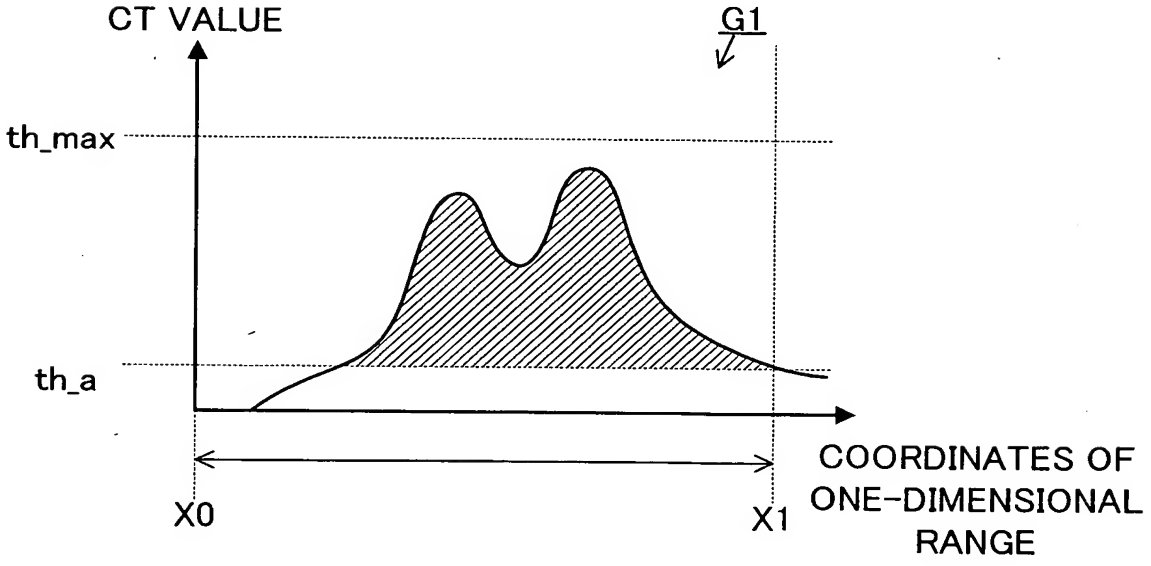


FIG.23B

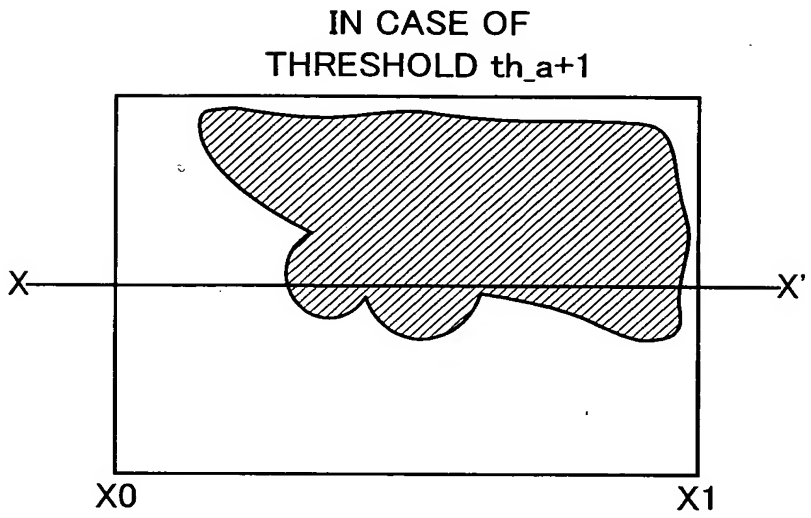


FIG.24A

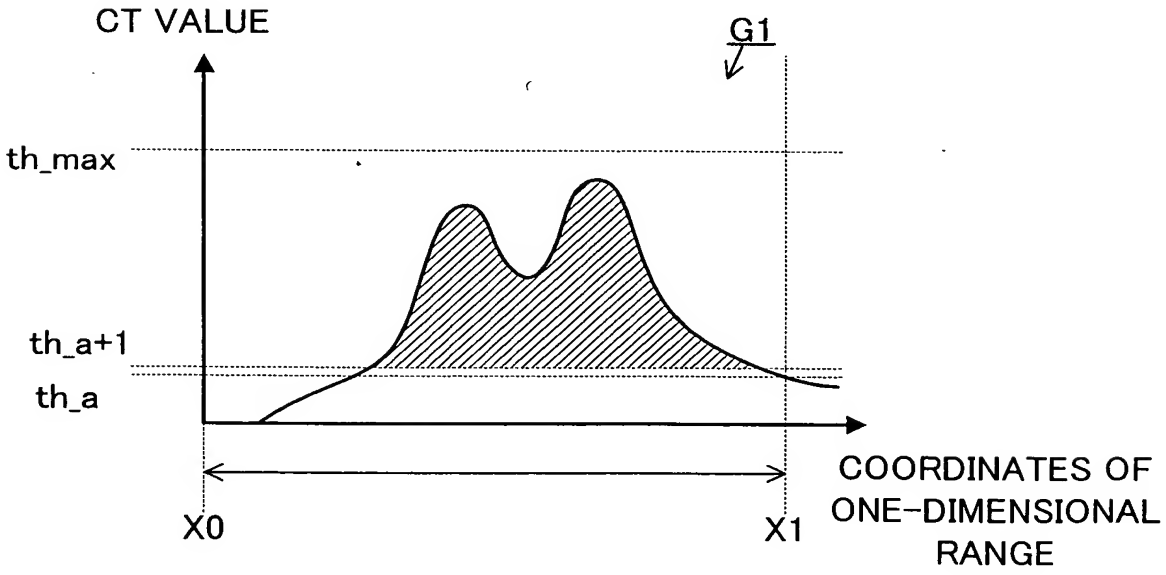


FIG.24B

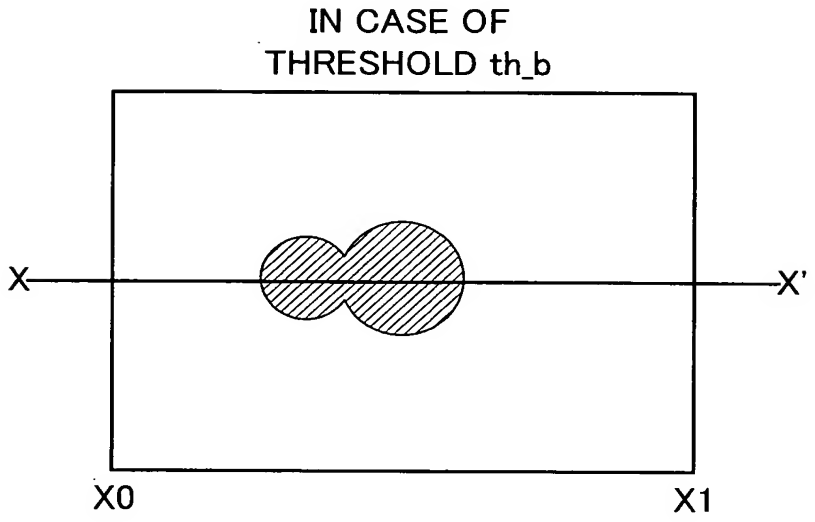


FIG.25A

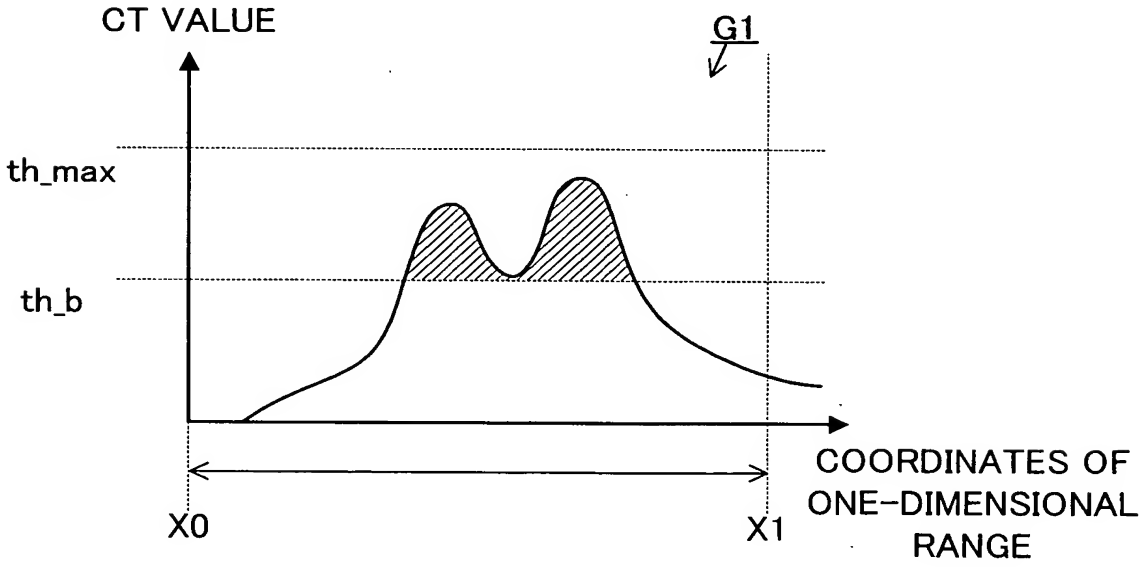


FIG.25B

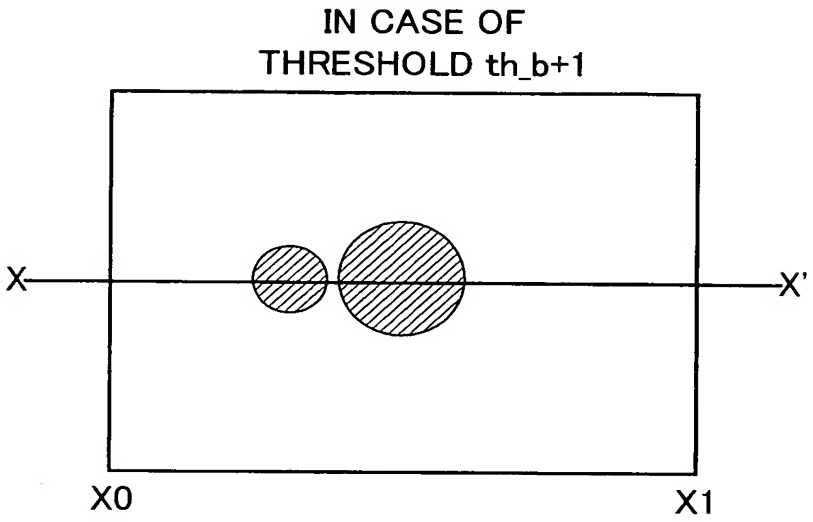


FIG.26A

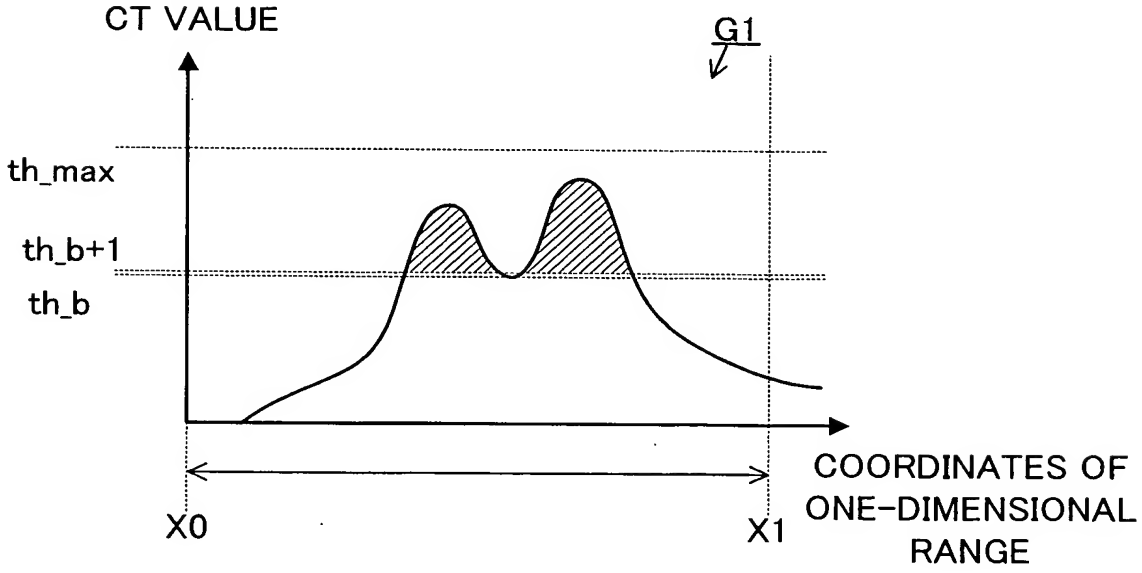


FIG.26B

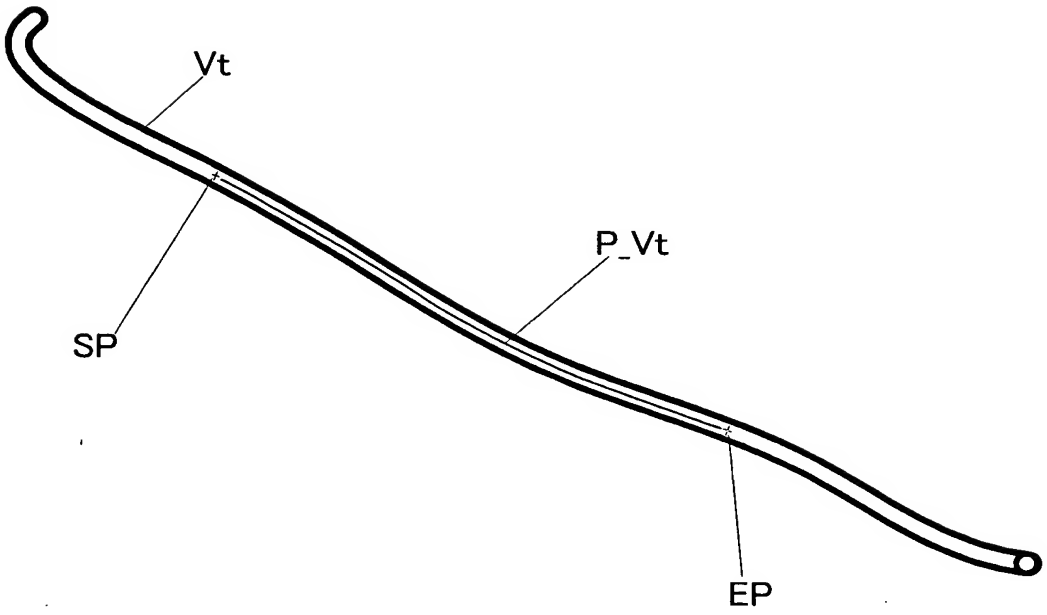


FIG.27

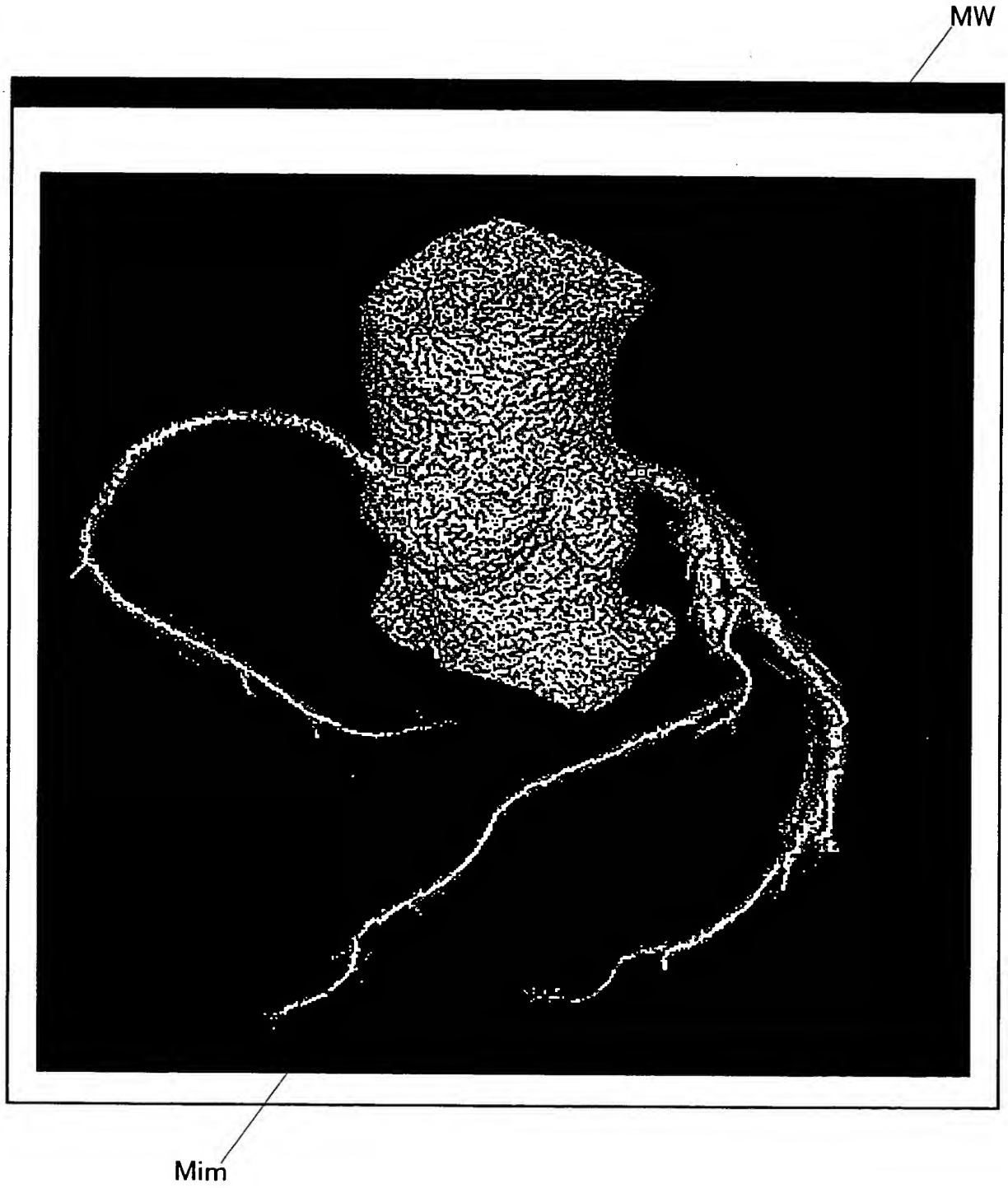


FIG.28

BEST AVAILABLE COPY

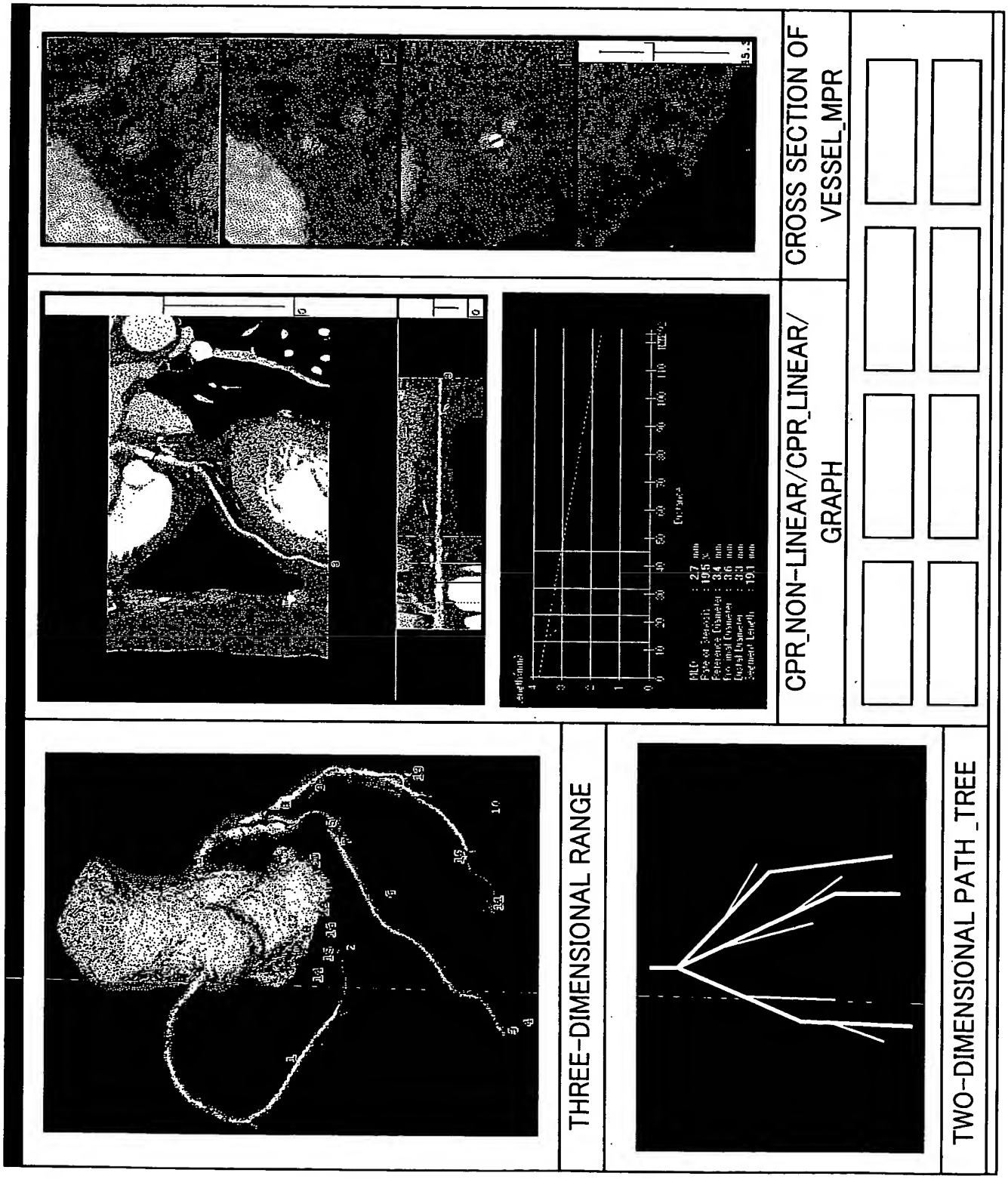


FIG.29

BEST AVAILABLE COPY

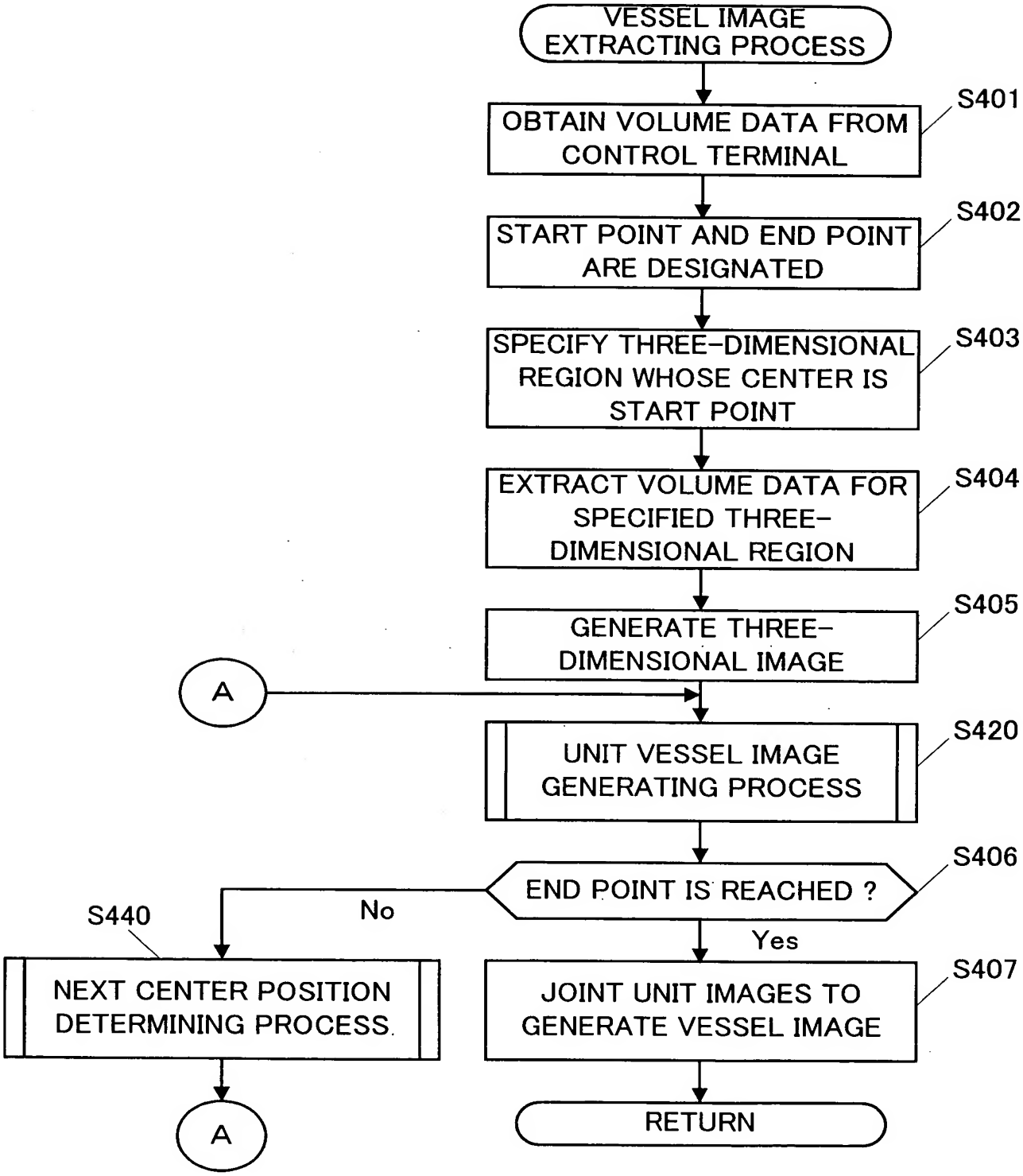

VESSEL IMAGE EXTRACTING PROCESS
OBTAIN VOLUME DATA FROM CONTROL TERMINAL
S401
START POINT AND END POINT ARE DESIGNATED
S402
SPECIFY THREE-DIMENSIONAL REGION WHOSE CENTER IS START POINT
S403
EXTRACT VOLUME DATA FOR SPECIFIED THREE-DIMENSIONAL REGION
S404
GENERATE THREE-DIMENSIONAL IMAGE
S405
A
UNIT VESSEL IMAGE GENERATING PROCESS
S420
END POINT IS REACHED ?
S406
No
Yes
S440
NEXT CENTER POSITION DETERMINING PROCESS
JOINT UNIT IMAGES TO GENERATE VESSEL IMAGE
S407
A
RETURN

FIG.30

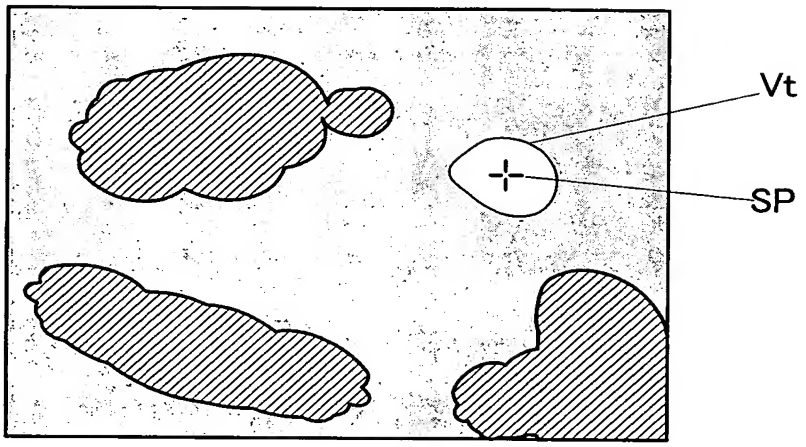


FIG.31A

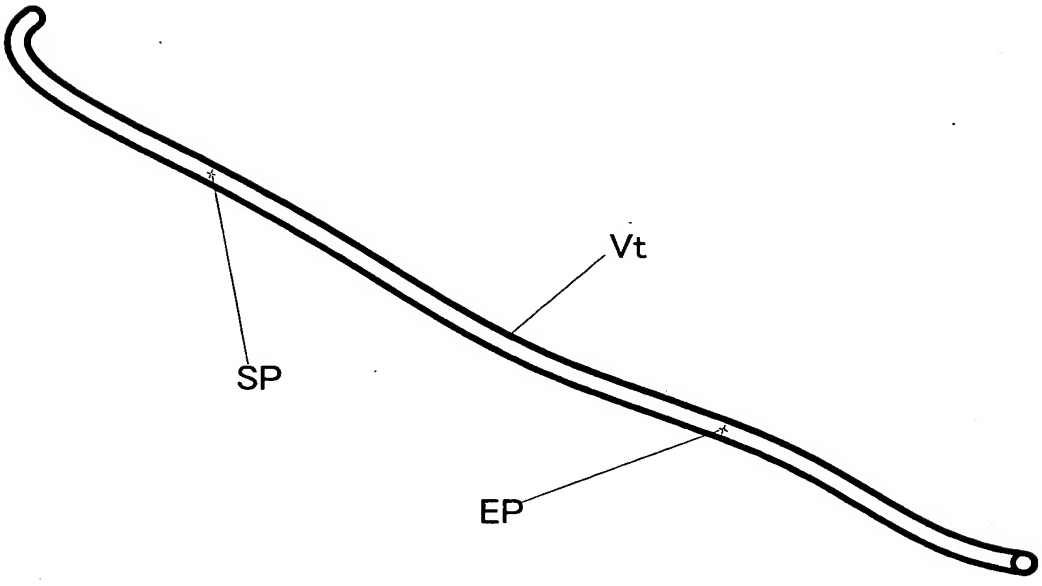


FIG.31B

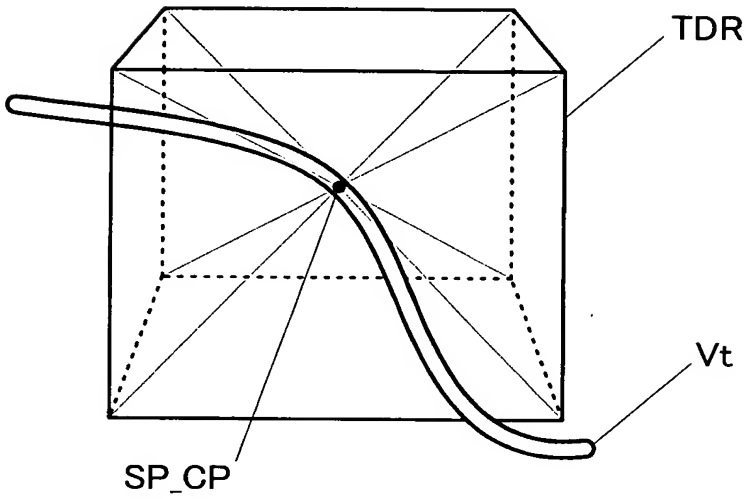


FIG.32A

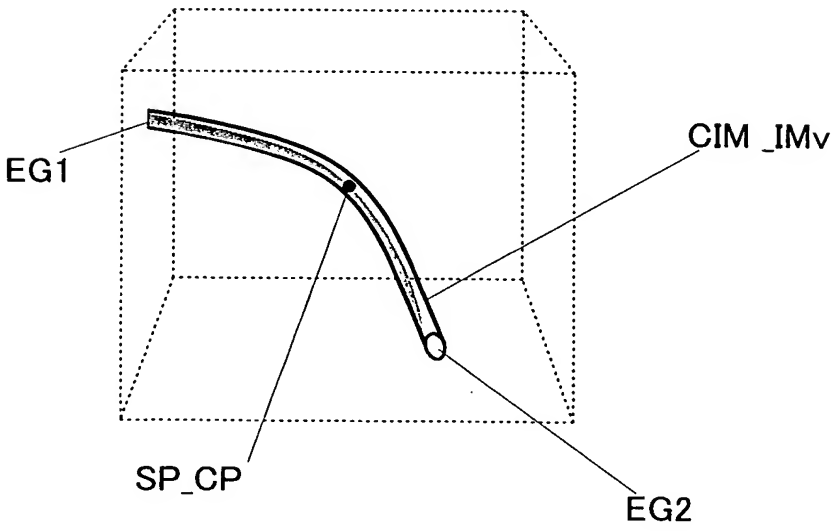


FIG.32B

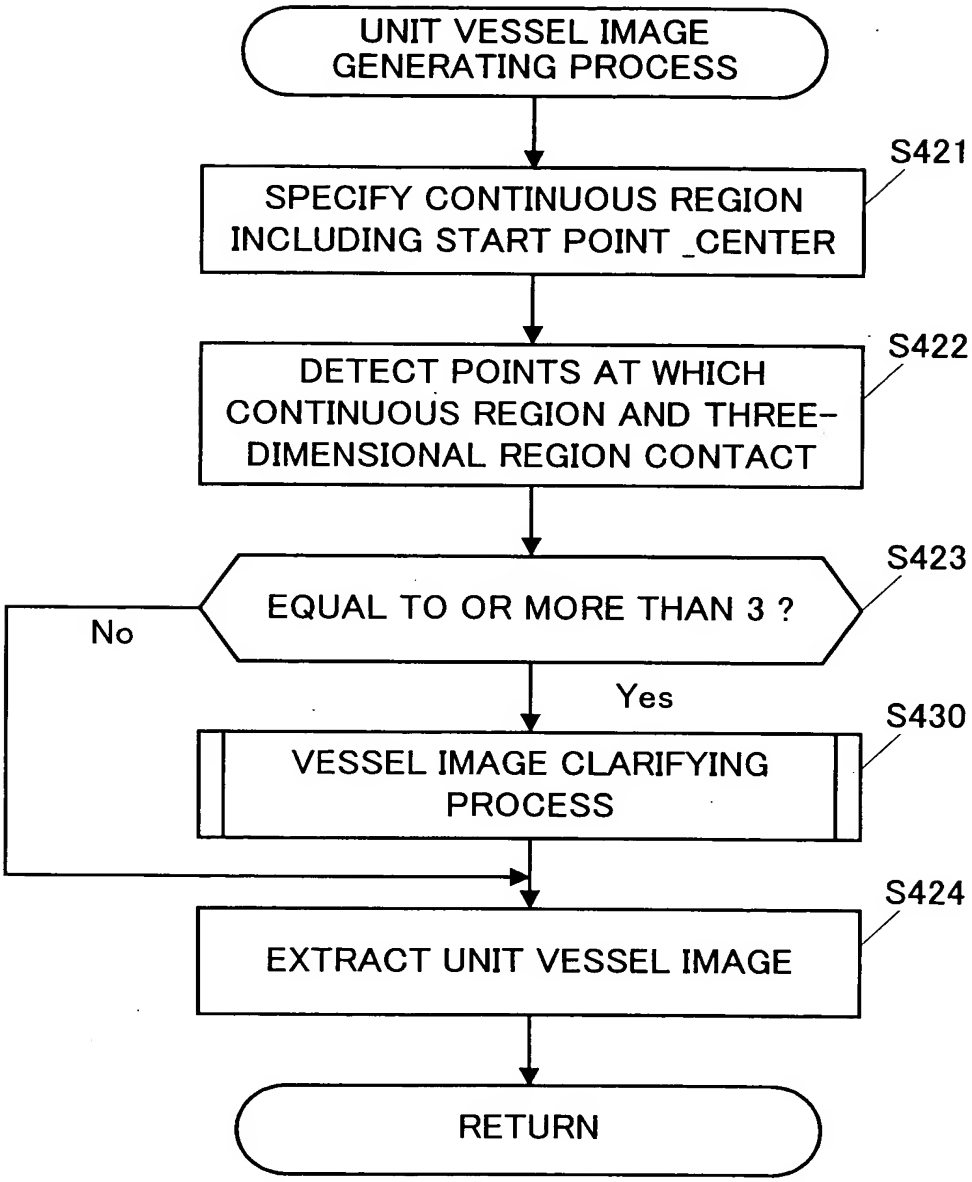

UNIT VESSEL IMAGE GENERATING PROCESS
S421
SPECIFY CONTINUOUS REGION INCLUDING START POINT _CENTER
S422
DETECT POINTS AT WHICH CONTINUOUS REGION AND THREE-DIMENSIONAL REGION CONTACT
S423
EQUAL TO OR MORE THAN 3 ?
No
Yes
S430
VESSEL IMAGE CLARIFYING PROCESS
S424
EXTRACT UNIT VESSEL IMAGE
RETURN

FIG.33

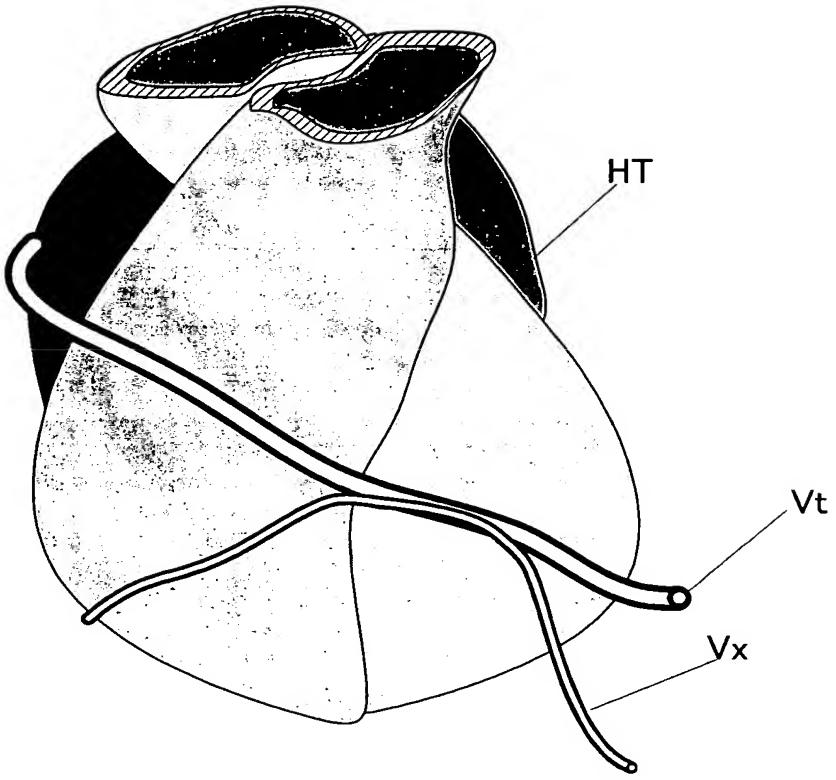


FIG.34

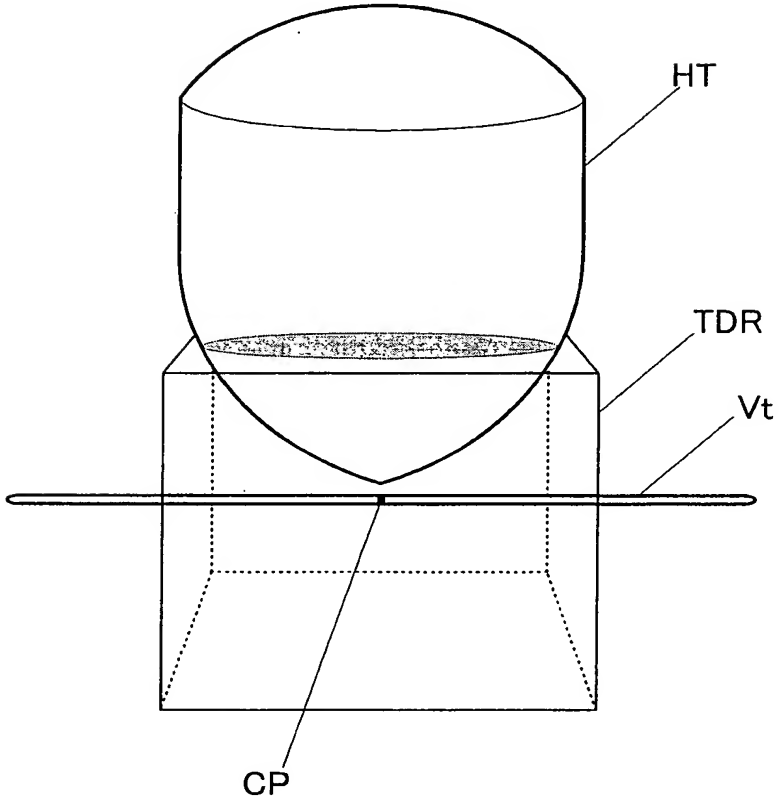


FIG.35A

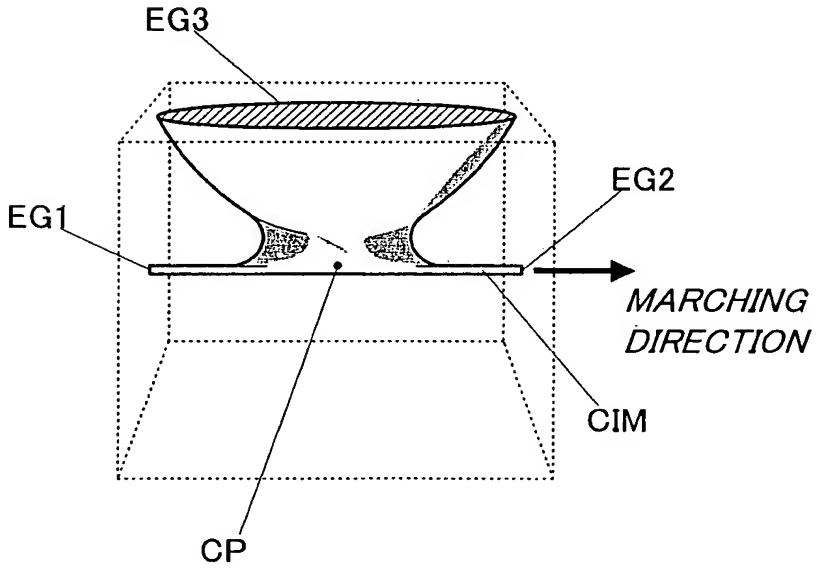


FIG.35B

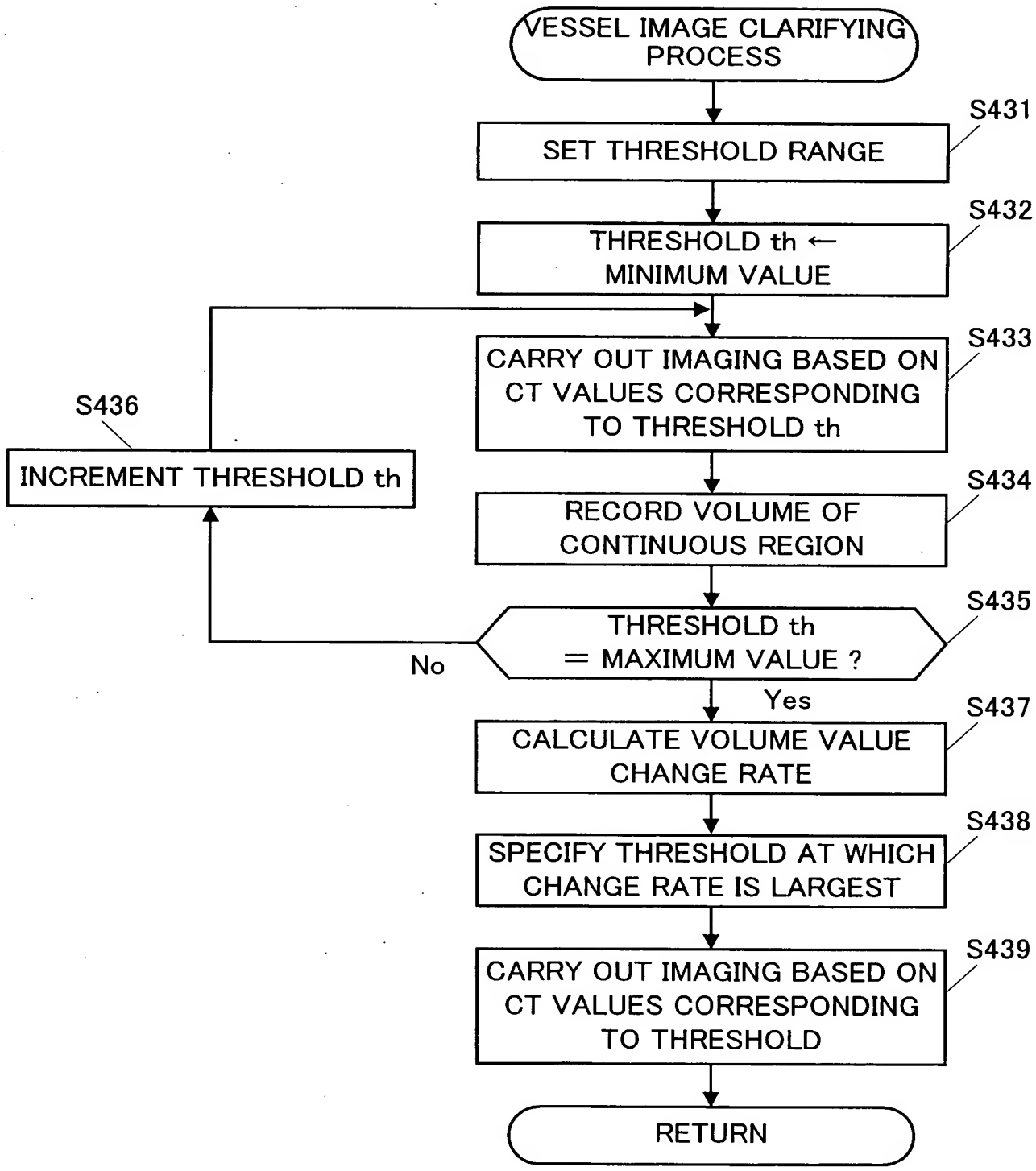

VESSEL IMAGE CLARIFYING PROCESS
S431
SET THRESHOLD RANGE
S432
THRESHOLD th ← MINIMUM VALUE
S433
CARRY OUT IMAGING BASED ON CT VALUES CORRESPONDING TO THRESHOLD th
S434
RECORD VOLUME OF CONTINUOUS REGION
S435
THRESHOLD th = MAXIMUM VALUE ?
No
S436
INCREMENT THRESHOLD th
Yes
S437
CALCULATE VOLUME VALUE CHANGE RATE
S438
SPECIFY THRESHOLD AT WHICH CHANGE RATE IS LARGEST
S439
CARRY OUT IMAGING BASED ON CT VALUES CORRESPONDING TO THRESHOLD
RETURN

FIG.36

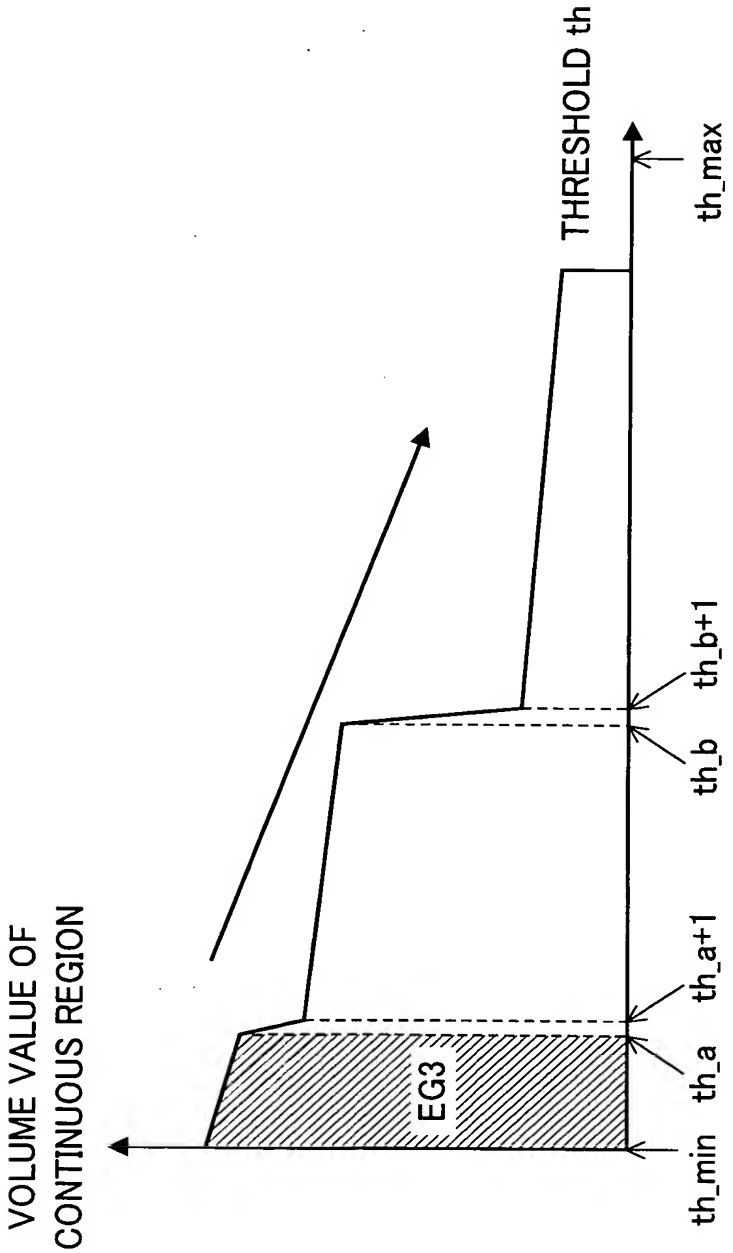

THRESHOLD th
th_max
th_b+1
th_b
th_a+1
th_a
th_min
EG3
VOLUME VALUE OF
CONTINUOUS REGION

FIG.37

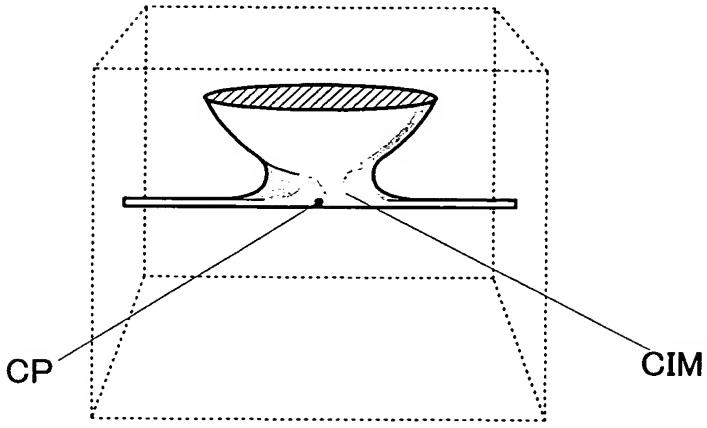


FIG.38A

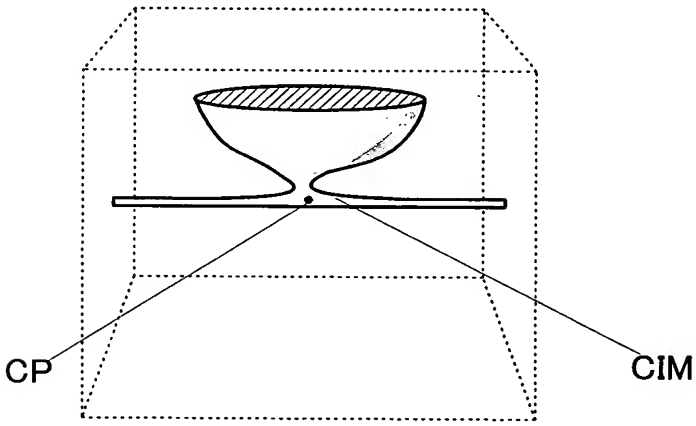


FIG.38B

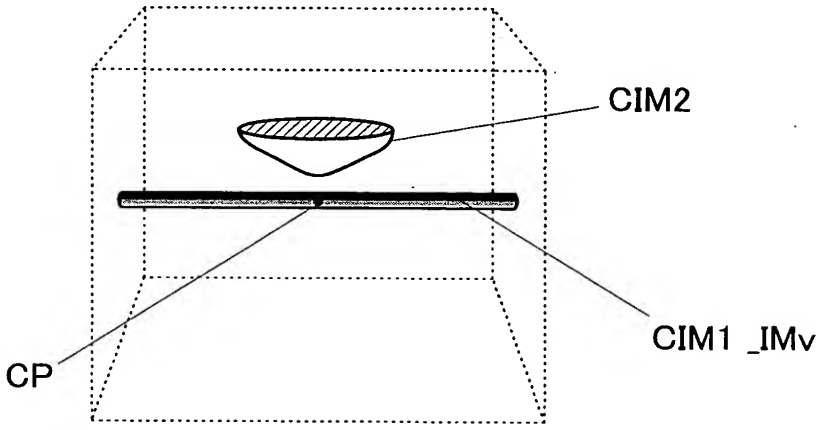


FIG.38C

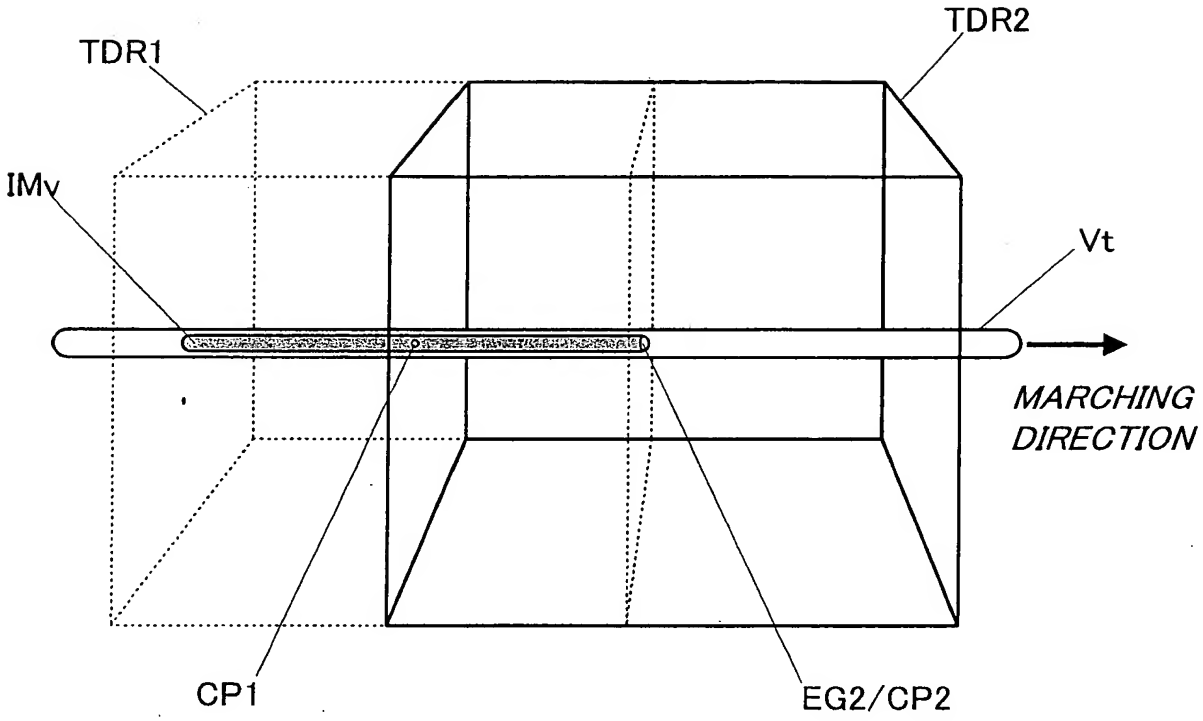


FIG.39A

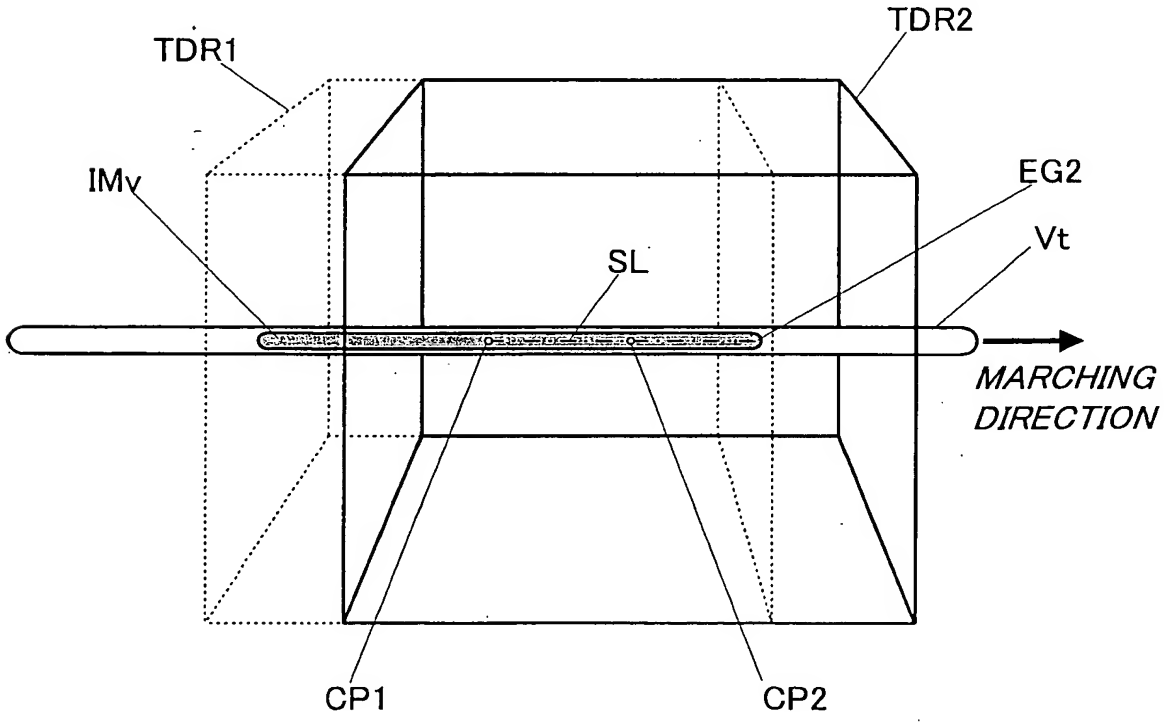


FIG.39B

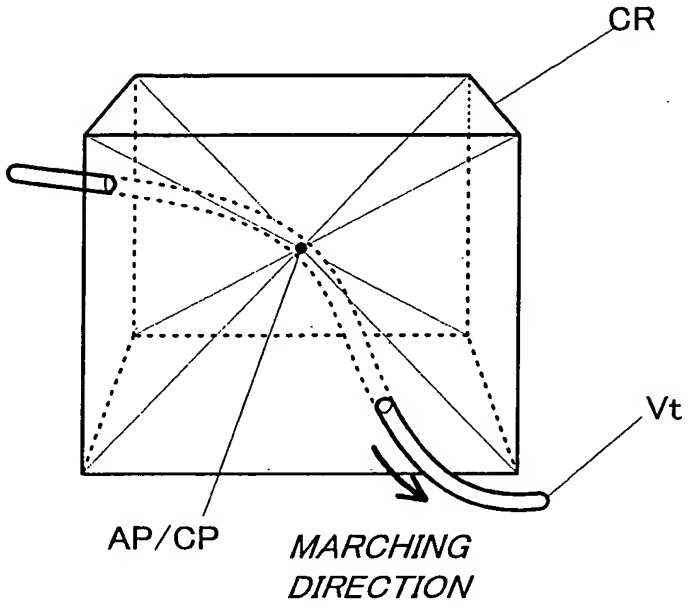


FIG.40A

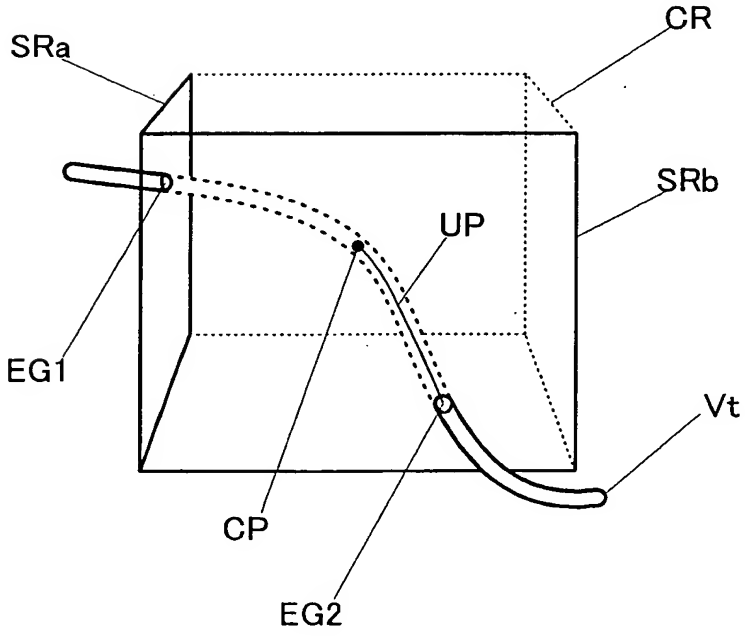


FIG.40B

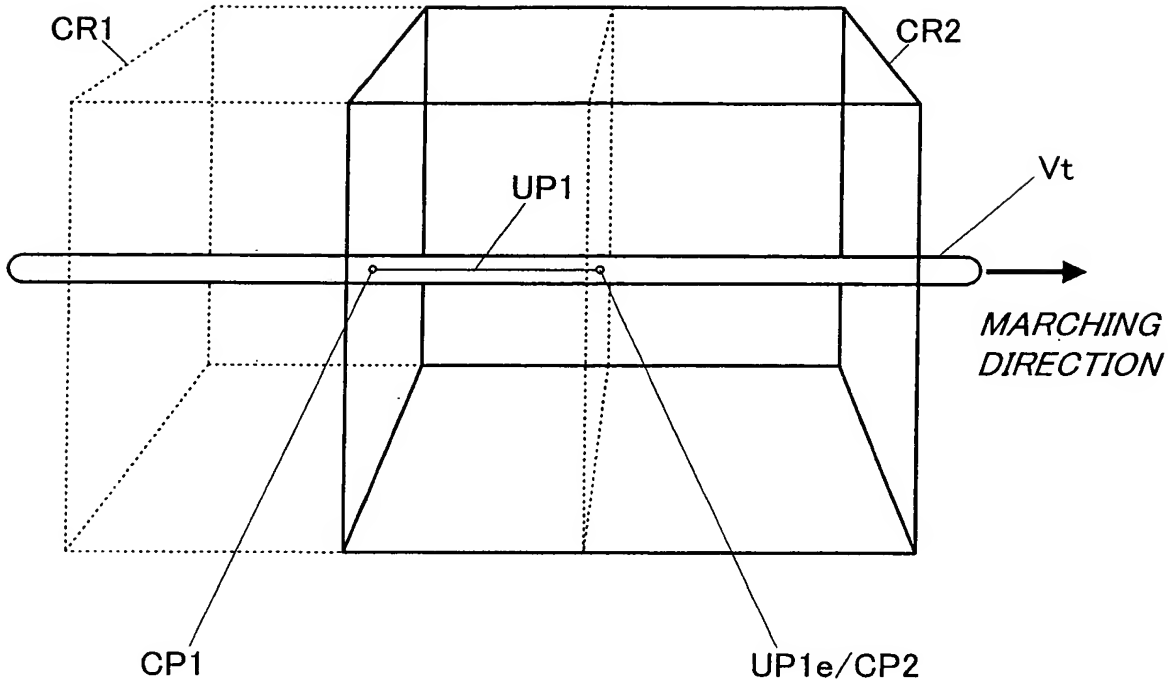


FIG.41A

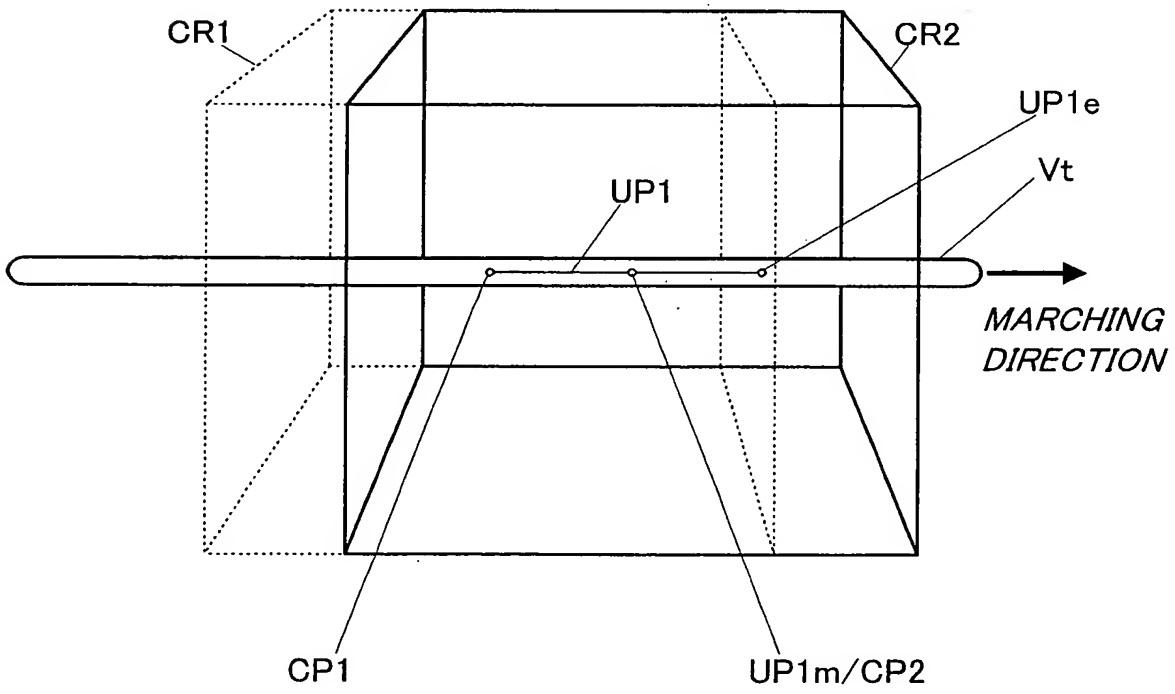


FIG.41B

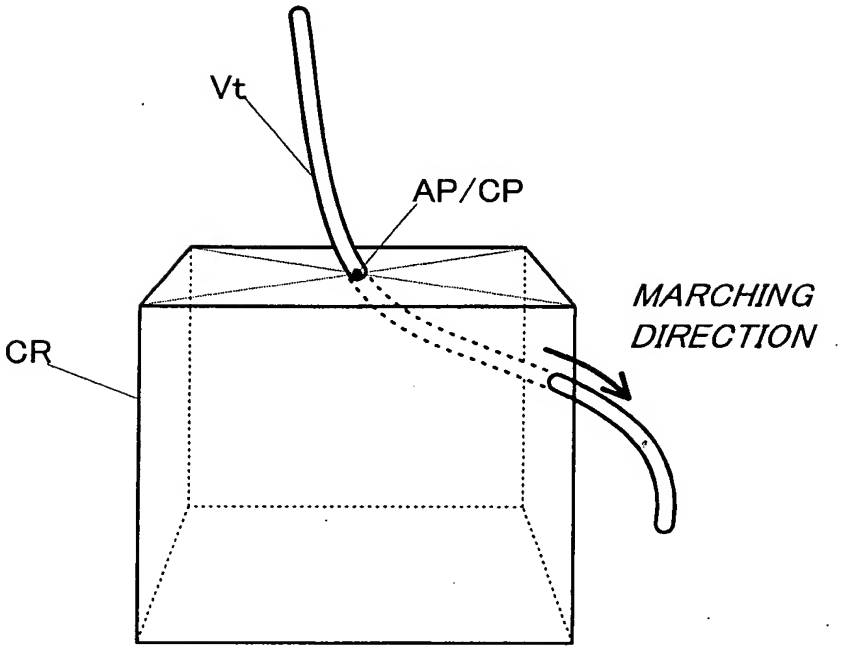


FIG.42A

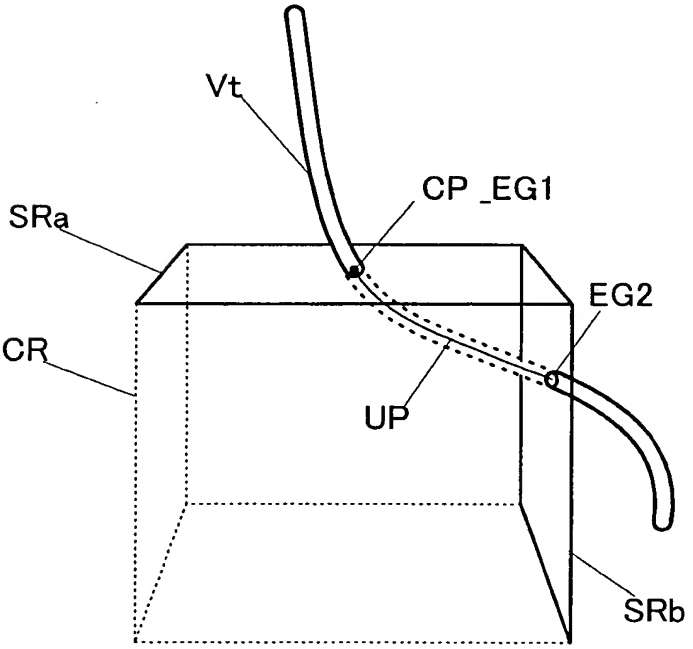


FIG.42B

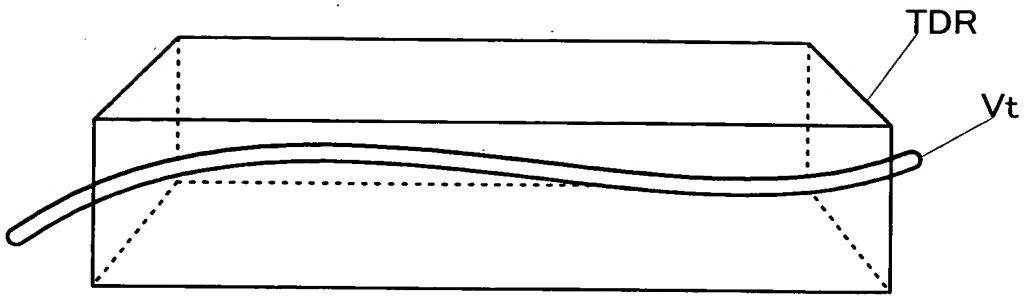


FIG.43A

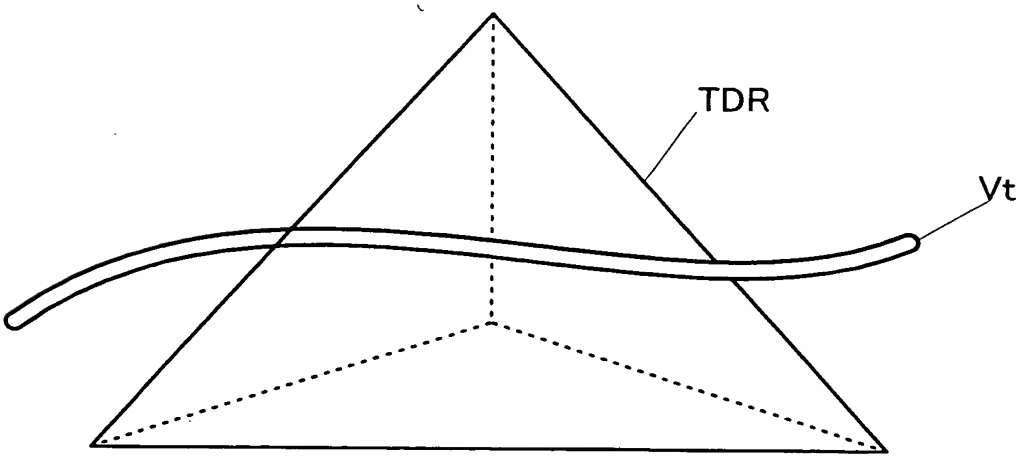


FIG.43B

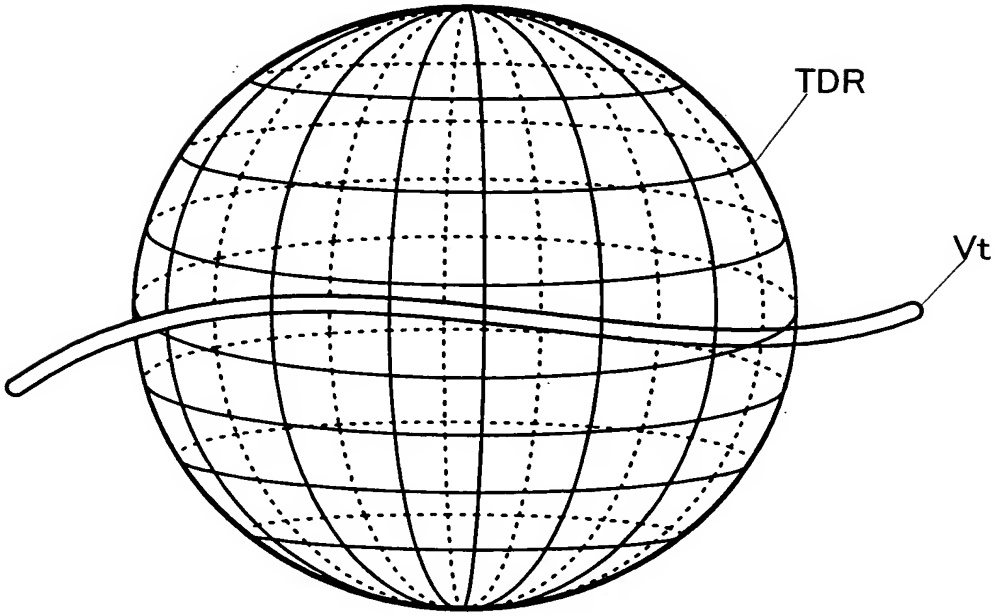


FIG.44A

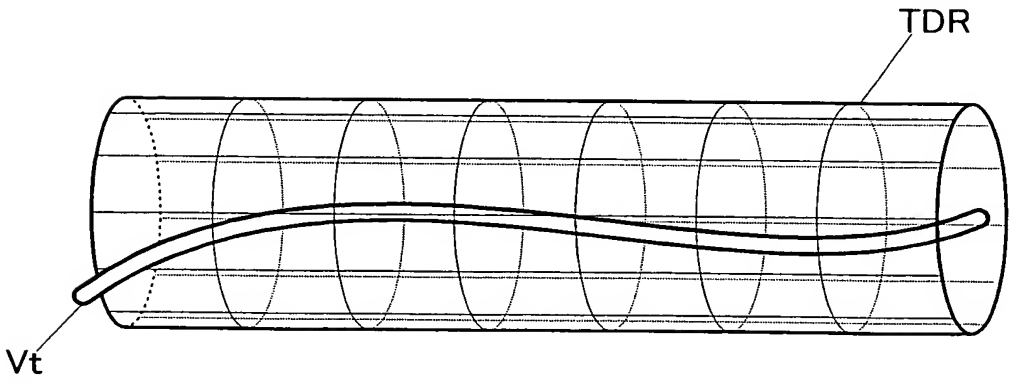


FIG.44B